This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

Stanford University Libraries
3 6105 027 600 829

Lincoln College, Topeka, 1865.

(Now Washburn College.)

In the recitation-room of Rev. Johns D. Parker, in this building, the Kansas Academy of Science was organized, September 1, 1868. The building is still standing, at Tenth and Jackson streets, in use as a ward schoolhouse.

TRANSACTIONS

OF THE

KANSAS

ACADEMY OF SCIENCE.

VOL. XVIII.

EDITED BY THE SECRETARY.

CONTAINS

LIST OF OFFICERS, PAST AND PRESENT; MEMBERSHIP LIST JANUARY 6, 1903; HISTORICAL SKETCH OF THE ACADEMY; CONSTITUTION AND BY-LAWS; MINUTES OF THE THIRTY-FOURTH AND THIRTY-FIFTH ANNUAL MEETINGS; AND SOME PAPERS READ.

TOPEKA, KANSAS:
W. Y. MORGAN, STATE PRINTER.
1903.

MICROFILM AVAILABLE

Officers of the Academy for 1903.

President.....	J. C. Cooper.....	Topeka, Kan.
Vice-president.....	Edward Bartow.....	Lawrence, Kan.
Vice-president.....	J. A. Yates.....	Ottawa, Kan.
Treasurer.....	Alva J. Smith.....	Emporia, Kan.
Secretary.....	G. P. Grimsley.....	Topeka, Kan.

Past Officers of the Academy.

PRESIDENTS.

1869, '70.... B. F. Mudge.	1891..... Robert Hay.
1871-'73.... John Fraser.	1892..... E. A. Popenoe.
1874-'78.... F. H. Snow.	1893..... E. H. S. Bailey.
1879, '80.... B. F. Mudge.	1894..... L. E. Sayre.
1881, '82.... J. T. Lovewell.	1895..... Warren Knaus.
1883..... Dr. A. H. Thompson.	1896..... D. S. Kelly.
1884, '85.... R. J. Brown.	1897..... S. W. Williston.
1886..... E. L. Nichols.	1898..... D. E. Lantz.
1887..... J. D. Parker.	1899..... E. B. Knerr.
1888..... J. R. Mead.	1900..... A. S. Hitchcock.
1889..... T. H. Dinsmore, jr.	1901..... E. Miller.
1890..... G. H. Failyer.	1902..... J. T. Willard.

VICE-PRESIDENTS.

1869, '70.... J. S. Whitman.	1889..... E. H. S. Bailey, G. H. Failyer.
1871..... B. F. Mudge.	1890..... D. S. Kelly, F. W. Cragin.
1872, '73.... B. F. Mudge, Dr. R. J. Brown.	1891..... F. W. Cragin, O. C. Charlton.
1874..... J. A. Banfield, J. D. Parker.	1892..... F. O. Marvin, Mrs. N. S. Kedzie.
1875..... B. F. Mudge, J. D. Parker.	1893..... J. T. Willard, E. B. Knerr.
1876, '77.... B. F. Mudge.	1894..... I. D. Graham, J. D. Hewitt.
1878..... B. F. Mudge, J. H. Carruth.	1895..... I. D. Graham, S. W. Williston.
1879-'82.... J. H. Carruth, Joseph Savage.	1896..... S. W. Williston, D. E. Lantz.
1883..... J. R. Mead, G. E. Patrick.	1897..... D. E. Lantz, A. S. Hitchcock.
1884..... F. H. Snow, Joseph Savage.	1898..... C. S. Parmenter, L. C. Wooster.
1885..... E. L. Nichols, G. H. Failyer.	1899..... A. S. Hitchcock, J. R. Mead.
1886..... J. D. Parker, N. S. Goss.	1900..... Ephraim Miller, J. C. Cooper.
1887..... J. R. Mead, E. H. S. Bailey.	1901..... J. C. Cooper, L. C. Wooster.
1888..... E. H. S. Bailey, T. H. Dinsmore, jr.	1902..... Edward Bartow, J. A. Yates.

SECRETARIES.

1869-'73.... J. D. Parker.	1893..... A. M. Collette.
1874, '75.... John Wherrell.	1894-'98.... E. B. Knerr.
1876, '77.... Joseph Savage.	1899-'01.... D. E. Lantz.
1878-'89.... E. A. Popenoe.	1902— .... G. P. Grimsley.
1890-'92.... E. H. S. Bailey.	

TREASURERS.

1869-'72.... F. H. Snow.	1891..... F. O. Marvin.
1873-'75.... R. J. Brown.	1892-'95.... D. S. Kelly.
1876, '77.... W. K. Kedzie.	1896..... L. E. Sayre.
1878-'83.... R. J. Brown.	1897-'00.... J. W. Beede.
1884, '85.... A. H. Thompson.	1901-'02.... E. C. Franklin.
1886-'90.... I. D. Graham.	

Membership of the Academy,

January 6, 1903.

HONORARY MEMBERS, elected in 1897.

Rev. Johns D. Parker, post chaplain	East Orange, N. J.
Arnold B. Johnson, United States Lighthouse Board	Washington, D. C.
W. A. Kellerman, Ph. D., Ohio State University	Columbus, Ohio.
Edw. L. Nichols, Ph. D., Cornell University	Ithaca, N. Y.
W. S. Franklin, Sc. D., Lehigh University	South Bethlehem, Pa.
S. W. Williston, Ph. D., University of Chicago, 1902	Chicago, Ill.

ASSOCIATE MEMBERS, elected in 1897.

Mrs. Mary E. Mudge	Manhattan.
Mrs. Mary Savage	Lawrence.

LIFE MEMBERS.

Dates printed in the following list signify date of election to membership in the Academy.

E. H. S. Bailey, Ph. D., 1883, University of Kansas	Lawrence.
S. A. Baldwin, 1879	Wabaunsee.
F. W. Cragin, M. S., 1880, Colorado College	Colorado Springs.
L. L. Dyche, M. S., 1881, University of Kansas	Lawrence.
E. C. Franklin, Ph. D., 1884, University of Kansas	Lawrence.
I. D. Graham, 1879	Topeka.
Warren Knaus, M. S., 1884	McPherson.
J. T. Lovewell, Ph. D., 1878	Topeka.
F. O. Marvin, C. E., 1884, University of Kansas	Lawrence.
Peter McVicar, D. D., 1868, Washburn College	Topeka.
J. R. Mead, 1879	Wichita.
Ephraim Miller, Ph. D., 1873, University of Kansas	Lawrence.
E. A. Popenoe, A. M., 1872, Kansas Agricultural College,	Manhattan.
L. E. Sayre, Ph. M., 1885, University of Kansas	Lawrence.
B. B. Smyth, 1880, State Museum	Topeka.
F. H. Snow, Ph. D., 1868, University of Kansas	Lawrence.
A. H. Thompson, D. D. S., 1873	Topeka.
D. M. Valentine, LL. D., 1878	Topeka.
M. L. Ward, D. D., 1880, Ottawa University	Ottawa.
J. T. Willard, M. S., 1883, Kansas Agricultural College	Manhattan.
S. W. Williston, Ph. D., 1880, University of Chicago	Chicago, Ill.

ACTIVE MEMBERS.

Geo. I. Adams, Ph. D., 1897, U. S. Geological Survey	Washington, D. C.
Orr Adams, 1898	Telluride, Colo.
L. D. Arnold, 1899, Salina Normal University	Salina.
Harvey W. Baker, 1902	Topeka.
F. D. Barker, 1901, Ottawa University	Ottawa.
Elam Bartholomew, M. S., 1895	Stockton.
Edward Bartow, Ph. D., 1897, University of Kansas	Lawrence.

68615

ACTIVE MEMBERS.

Wm. C. Bauer, A. M., 1897, Baker University ..... Baldwin.
J. W. Beede, Ph. D., 1894, University of Indiana..... Bloomington, Ind.
Edw. Bumgardner, M. D., 1896..... Lawrence.
F. W. Bushong, B. S., 1896, Kansas City University..... Kansas City, Kan.
Chas. S. Caldwell, 1895 ..... Costa Rica.
H. W. Charles, 1899, Superintendent of Reform School... Topeka.
T. D. A. Cockerell, Ph. D., 1895..... Las Vegas, N. M.
Clarence L. Cole, M. D., 1902, Kansas Medical College... Topeka.
J. C. Cooper, 1899 ..... Topeka.
F. F. Crevecœur, 1899 ..... Onaga.
F. B. Dains, Ph. D., 1902, Washburn College..... Topeka.
John S. Dawson, 1899..... Hill City.
R. B. Dunlevy, B. S., 1896, Southwest Kansas College... Winfield.
B. F. Eyer, B. S., 1894, Kansas Agricultural College..... Manhattan.
Geo. H. Failyer, Ph. D., 1901, Department of Agriculture, Washington, D. C.
A. O. Garrett, 1901, high school..... Salt Lake City, Utah.
G. P. Grimsley, Ph. D., 1895, Washburn College..... Topeka.
C. F. Gustafson, 1899, University of Kansas..... Lawrence.
H. J. Harnly, B. S., 1893, McPherson College..... McPherson.
J. Arthur Harris, 1900..... St. Louis, Mo.
W. A. Harshbarger, B. S., 1902, Washburn College ..... Topeka.
Leon W. Hartman, 1901..... Manhattan.
E. H. Heacock, B. S., 1896, high school ..... Topeka.
W. E. Henderson, 1901, high school..... Iola.
A. S. Hitchcock, M. S., 1892, Department of Agriculture, Washington, D. C.
Ross Hopkins, 1898, Johns Hopkins University .... Baltimore, Md.
Geo. W. Hoxie, M. D., 1902, University of Kansas ..... Lawrence.
Thos. M. Iden, 1897, State Normal School..... Emporia.
F. B. Isely, 1902, high school..... Wichita.
T. B. Jennings, United States Weather Bureau..... Topeka.
John J. Jewett, 1902..... Topeka.
Carl Johns, 1900, Bethany College..... Lindsborg.
A. W. Jones, B. S., 1894, Kansas Wesleyan University... Salina.
Hugo Kahl, 1897, Carnegie Museum..... Pittsburg, Pa.
W. H. Keller, 1898..... Wetmore.
E. B. Knerr, Sc. D., 1889, Midland College..... Atchison.
D. E. Lantz, M. S., 1887, Kansas Agricultural College ... Manhattan.
Pierce Larkin, 1902, University of Oklahoma ..... Norman, Okla.
H. T. Martin, 1902, University of Kansas..... Lawrence.
R. Matthews, D. D. S., 1898 ..... Wichita.
Elmer V. McCollum, 1902, University of Kansas..... Lawrence.
Edith A. McIntyre, B. S., Kansas Agricultural College.. Manhattan.
S. G. Mead, 1899..... McPherson.
Grace R. Meeker, 1899..... Ottawa.
Mrs. A. H. Merrell, 1898..... Los Angeles, Cal.
Elmer P. Monahan, 1901, Baker University..... Baldwin.
L. N. Morscher, 1900..... Lawrence.
J. H. Newby, 1899..... Osage City.
A. M. Nissen, A. M., 1888, public schools..... Wetmore.
D. H. Otis, M. S., 1897, Kansas Agricultural College..... Manhattan.
W. K. Palmer, M. E., 1897, consulting engineer..... Kansas City, Mo.

ACTIVE MEMBERS.

Norman Plass, 1902, president of Washburn College	Topeka.
S. F. Poole, B. S., 1902, Fairmount College	Wichita.
C. L. Pribble	Topeka.
J. M. Price, jr., B. S., 1900	Atchison.
C. S. Prosser, M. S., 1892, Ohio State University	Columbus, Ohio.
W. F. Rice, 1902, public schools	Richmond.
Arthur Ringer, 1902, county high school	Effingham.
J. H. Schaffner, B. S., 1902, Ohio State University	Columbus, Ohio.
E. H. Sellards, B. S., 1900, Yale University	New Haven, Conn.
C. H. Shattuck, 1899, Campbell University	Holton.
J. L. Shearer, 1902, public schools	Halstead.
E. T. Shelley, M. D., 1892	Atchison.
Alva J. Smith, 1893	Emporia.
Eugene G. Smyth, 1901	Topeka.
Chas. H. Sternberg, 1895	Lawrence.
Teresa Stevenson, 1901	Ottawa.
R. S. Sherwin, 1901, University of Oklahoma	Norman, Okla.
F. J. Titt, B. S., 1898, Kingfisher College	Kingfisher, Okla.
C. D. Weaver, M. D., 1902	McPherson.
Geo. F. Weida, Ph. D., 1897, Kansas Agricultural College,	Manhattan.
J. E. Welin, 1899, Bethany College	Lindsborg.
J. M. Westgate, 1900, University of Chicago	Chicago, Ill.
E. M. Williams, 1901	Wichita.
H. I. Woods, M. S., 1902, Washburn College	Topeka.
L. C. Wooster, 1897, State Normal School	Emporia.
J. A. Yates, Ph. D., 1898, Ottawa University	Ottawa.

Historical Sketch of the Academy.

THE organization of a Kansas association of scientific men at an early date was due to the efforts of Rev. Johns D. Parker and Prof. B. F. Mudge, who, in July, 1868, issued a call signed by seventeen men for a meeting of all persons in the state interested in natural sciences to meet in Topeka.

The first meeting was held in September of that year, in Lincoln College (now Washburn), and the Kansas Natural History Society was organized and officers elected. The object, as stated in the original draft of the constitution, "shall be to increase and diffuse a knowledge of the natural sciences, particularly in relation to the state of Kansas." At the fourth annual meeting, held in Leavenworth in 1871, the name was changed to the Kansas Academy of Science. In 1873 the Academy became a coordinate department of the State Board of Agriculture by the terms of the following act of the legislature:

"The Academy of Science shall be a coordinate department of the State Board of Agriculture, with their office in the agricultural rooms, where they shall place and keep for public inspection the geological, botanical and other specimens, the same to be under the direction and control of the officers of the said Academy of Science. An annual report of the transactions of said Academy of Science shall be made on or before the 15th day of November of each year to the State Board of Agriculture, for publication in the annual transactions of said board."

The Academy has increased in membership from the original small body of scientists to over 120. It has held thirty-five annual meetings, of which seventeen have been held in Topeka, five in Lawrence, three in Manhattan, two in Leavenworth, two in Emporia, and one each in Atchison, Baldwin, Iola, McPherson, Ottawa, Wichita.

Eighteen volumes of the Transactions have been published, varying in size from a few pages in the early numbers to 350 pages in the later volumes. These publications contain many papers of recognized scientific value. The exchange list includes over 500 names of societies and libraries.

The Academy has recently moved into new quarters, including an office and library room, and a large tile-floor museum for the economic collections of the state. The excellent Goss ornithological collection and the natural history collections are now placed in separate rooms prepared especially for them.

Constitution of the Academy.

SECTION 1. This association shall be called the Kansas Academy of Science.

SEC. 2. The objects of this Academy shall be to increase and diffuse knowledge in the various departments of science.

SEC. 3. Members of this Academy shall consist of two classes, active and honorary (including associate.) *Active members* may be annual or life members. *Annual members* may be elected at any meeting of the Academy, and shall sign the constitution and pay a fee of one dollar and annual dues of one dollar; but the secretary and treasurer shall be exempt from the payment of dues during the years of their service. Any person who shall at one time contribute twenty dollars to the funds of this Academy may be elected a *life member* of the Academy, free of assessment. Any member who has paid dues to the Academy for ten consecutive years, or who has been legally exempt during any portion of that time, may be elected a *life member* on the payment of ten dollars. Any member who has been a member of this Academy in good standing for twenty years may be elected a *life member* without payment of further fees or dues. *Honorary members* may be elected on account of special prominence in science, on the written recommendation of two members of the Academy. In any case, a two-thirds vote of members present shall elect to membership. Applications for membership in any of the foregoing classes shall be referred to a committee on applications for membership, who shall consider such application and report to the Academy before the election.

SEC. 4. The officers of this Academy shall be chosen by ballot at the annual meeting, and shall consist of a president, two vice-presidents, a secretary, and a treasurer, who shall perform the duties usually pertaining to their respective offices. The president, secretary and treasurer shall constitute an executive committee. The secretary shall have charge of all the books, collections and material properly belonging to the Academy.

SEC. 5. Unless otherwise directed by the Academy, the annual meeting shall be held at such time and place as the executive committee shall designate. Other meetings may be called at the discretion of the executive committee.

SEC. 6. This constitution may be altered or amended at any annual meeting, by a vote of three-fourths of attending members of at least one year's standing. No question of amendment shall be decided on the day of its presentation.

By-laws of the Academy.

I. The first hour, or such part thereof as shall be necessary, in each session, shall be set aside for the transaction of the business of the Academy. The following order of business shall be observed, as far as practicable:

1. Opening.
2. Reports of officers.
3. Reports of standing committees.
4. Appointment of special committees.
5. Unfinished business.
6. New business.
7. Reports of special committees.
8. Election of officers.
9. Election of members.
10. Program.
11. Adjournment.

II. The president shall deliver a public address on the evening of one of the days of the meeting, at the expiration of his term of office.

III. No meeting of this Academy shall be held without a notice of the same having been published in the papers of the state at least thirty days previous.

IV. No bill against the Academy shall be paid by the treasurer without an order signed by the president and secretary.

V. Members who shall allow their dues to remain unpaid for two years, having been annually notified of their arrearage by the treasurer, shall have their names stricken from the roll.

VI. The secretary shall have charge of the distribution, sale and exchange of the published Transactions of the Academy, under such restrictions as may be imposed by the executive committee.

VII. Eight members shall constitute a quorum for the transaction of business.

VIII. The time allotted to the presentation of a single paper shall not exceed fifteen minutes.

IX. No paper shall be entitled to a place on the program unless the manuscript, or an abstract of the same, shall have been previously delivered to the secretary.

KANSAS ACADEMY OF SCIENCE MUSEUM OF MINERAL INDUSTRIES.
Capitol Building, Topeka.

MINUTES.

Thirty-fourth Annual Meeting, Kansas Academy of Science, December 30 and 31, 1901, and January 1, 1902.

IOLA, KAN., December 30, 1901.

THE Kansas Academy of Science assembled in thirty-fourth annual meeting, at Iola, in the high-school auditorium, and was called to order at 7:30 o'clock P. M., by the president, Ephraim Miller.

The minutes of the adjourned session of January 25, 1901, held in Representative hall, Topeka, were read by the secretary and declared approved.

The following members were present at the opening session: Edward Bartow, F. F. Crevecœur, L. L. Dyche, Warren Knaus, D. E. Lantz, J. T. Lovewell, D. F. McFarland, J. R. Mead, Grace Meeker, Ephraim Miller, L. N. Morscher, L. E. Sayre, A. J. Smith, B. B. Smyth, M. L. Ward, J. T. Willard.

The president appointed the following committees:

On program: D. E. Lantz, Warren Knaus, and B. B. Smyth.

On membership: L. E. Sayre, J. T. Willard, and J. R. Mead.

Baxter McClain, Esq., of the city of Iola, welcomed the Academy to the city in a short address, and President Miller responded informally for the Academy.

The committee on membership recommended the following persons for membership in the Academy: Elmer P. Monahan, Baldwin; F. D. Barker, Ottawa; Miss Teresa Stevenson, Ottawa; A. O. Garrett, Fort Scott; Willis E. Henderson, Iola; Samuel L. Sargent, Wichita; Leon W. Hartman, Manhattan. Also, for reinstatement: Geo. H. Failyer, Manhattan; Chas. H. Sternberg, Lawrence.

On motion, the secretary was instructed to cast the ballot of the Academy for these persons, and they were duly declared elected members.

The committee on program reported, and the reading of papers was then taken up.

1. Wild animals I have known in Sedgwick county, by J. R. Mead.
2. The black squirrel in Kansas, by Elmer P. Monahan.
3. Notes on the trees, shrubs and vines in the southern part of the Cherokee Nation, by Chas. N. Gould. (Read by the secretary.)
4. The material *versus* the immaterial in medicine, by L. E. Sayre.

After announcements by President Miller, the Academy adjourned, to meet at nine A. M., December 31.

TUESDAY MORNING, December 31, 1901.

The Academy was called to order at 9:30 o'clock.

Minutes of the Monday evening session were read and approved.

President Miller appointed the following additional committees:

On nominations: J. T. Lovewell, Edw. Bartow, and A. J. Smith.

On necrology: Warren Knaus and B. B. Smyth.

On resolutions: M. L. Ward, L. L. Dyche, and J. R. Mead.

On place of meeting: J. T. Willard, G. H. Failyer, and Edw. Bartow.

Notice of an additional amendment to the constitution was given by Warren Knaus. The word "librarian" was to be stricken out of section 3.

The reading of papers was then continued:

5. Additions to the list of Kansas Coleoptera for 1901, by Warren Knaus.

6. Collecting Coleoptera in Utah and Wyoming, by Warren Knaus.

7. Additions to the list of the Hemipterous fauna of Kansas, by F. F. Crevecœur.

8. Remarks on habits of *Cynomys ludovicianus*, by D. E. Lantz.

9. On the still used for the purpose of obtaining distilled water for the University of Kansas, with some tests on the quality of the product, by E. H. S. Bailey. (Read by Edw. Bartow, in the absence of the author.)

10. Gold in Kansas shales, by J. T. Lovewell.

11. The nutritive value of buffalo-grass, by J. T. Willard.

12. On the use of a solution of alum as a standard acid in acidimetry, by H. P. Cady. (Read by title.)

13. Reactions between basic and acid amides in liquid ammonia, by E. C. Franklin and O. F. Stafford. (Read by title.)

14. Some pure sandstone waters, by E. H. S. Bailey. (Read by D. F. McFarland, in the absence of the author.)

On motion, the Academy adjourned, to meet at four P. M.

TUESDAY AFTERNOON, December 31, 1901.

At 1:15 o'clock, through the courtesy of the Iola Commercial Club, the members of the Academy enjoyed a trip to Gas City, Lanyonville, and La Harpe, on the new electric railway. Upon their return to Iola they were shown through the water-works and the large smelter of the Lanyon Zinc Company. Two trips were also conducted to the Iola Cement Works near the city.

The Academy was called to order at 4:30 o'clock.

The committee on membership recommended the following persons for active membership: Jesse B. Norton, Manhattan; Herbert F. Roberts, Manhattan; R. S. Sherwin, Norman, Okla. The committee also recommended for life membership the following persons, after

they comply with the conditions prescribed by the constitution; Geo. H. Failyer, Manhattan; L. L. Dyche, Lawrence; J. T. Willard, Manhattan; D. E. Lantz, Manhattan.

On motion, all the persons named were duly elected.

The reading of papers was then resumed:

15. Progress and possibilities of cereal-breeding for Kansas, by H. F. Roberts. (Read by title.)

16. A physical examination of gypsum cement wall plasters, by G. P. Grimsley. (Read by title.)

17. On the eastern extension of the Kansas-Oklahoma Red-beds, by C. N. Gould. (Read by title.)

18. On a new plesiosaur, by S. W. Williston. (Read by title.)

19. The Ottawa gas-wells, by J. A. Yates. (Read by title, the author giving a brief abstract.)

20. The Comanche Cretaceous in Oklahoma, by C. N. Gould. (Read by title.)

21. Notes on the theories of gypsum deposits, by R. S. Sherwin. (Read by the secretary.)

22. On the disappearance of ponds and streams in central Kansas, by S. G. Mead. (Read by the secretary.)

23. On certain methods of the geometry of position, by Arnold Emch. (Read by title.)

24. The value of digestive ferments and their allies in medicine, by L. E. Sayre.

25. Further notes on the medicinal plants of Kansas, including economic values, by L. E. Sayre. (Read by title.)

The committee on place of next meeting reported, favoring Manhattan as the place for the next meeting.

On motion of B. B. Smyth, Topeka was substituted for Manhattan in the report, and the report, as amended, was adopted.

The reading of papers was resumed:

26. Origin of the names of Kansas streams, by J. R. Mead.

27. Some peculiar psychic phenomena, by H. J. Harnly. (Read by title.)

28. Tabulated list of the medicinal plants of Kansas, with their reputed therapeutic properties, by B. B. Smyth. (Read by title, with an oral abstract.)

29. Mica mining in Maine, by W. N. Logan. (Read by title.)

30. Notes on Kansas Hemiptera, by Jesse B. Norton. (Read by title.)

31. A list of the Kansas Hemiptera, by E. A. Popenoe. (Read by title.)

32. The flora of a *Phragmites* bog in Kansas, by Jesse B. Norton. (Read by title.)

33. Modern necessities in the teaching of elementary botany, by H. L. Roberts. (Read by title.)

34. Some Kansas Lygæidæ, by Jesse B. Norton. (Read by title.)

35. The relation between specific gravity and nitrogen content in the corn kernel, by J. T. Willard.

The committee on membership reported, recommending, for active membership, Edward M. Williams, Wichita; and for life membership, Erasmus Haworth, Lawrence; E. H. S. Bailey, Lawrence.

On motion, these men were elected, the secretary casting the ballot of the Academy.

On motion, the Academy adjourned, to meet at 7:30 P. M.

TUESDAY EVENING, December 31, 1901.

The Academy was called to order by past Pres. Geo. H. Failyer.

President Miller delivered the annual address, choosing for his subject, "The Growth of Science during the Nineteenth Century." At the close of the address, President Miller resumed the chair.

The following papers were then read:

36. A list of birds observed in Sedgwick county, by R. Matthews. (Read by title).

37. A pre-glacial gap on Colby creek, Shawnee county, by B. B. Smyth.

38. The economic geology of Iola and vicinity, by G. P. Grimsley.

39. The physiographic divisions of Kansas, by Geo. I. Adams. (The secretary, in the absence of the author, read an outline of the paper and distributed the outline, with maps, to all present.)

40. The Permian beds of the Big Wichita valley of Texas, by Chas. A. Sternberg.

On motion of Professor Sayre, the secretary was instructed to communicate to Geo. I. Adams the thanks of the Academy for his paper and outlines.

The committee on membership recommended, for active membership, Eugene G. Smyth, of Topeka, and for life membership, M. L. Ward, of Ottawa. On motion, they were duly elected.

The committee on necrology reported the death during the past year of Geo. H. Curtis, of McPherson, an active member, and Dr. George T. Fairchild, of Berea, Ky., an honorary member.

On motion, it was ordered that a memorial of Col. N. S. Goss be published in the next volume of the transactions.

The committee on resolutions reported the following, which was adopted:

Resolved, That the thanks of the Kansas Academy of Science are rendered to the Commercial Club of Iola, for courtesies tendered in exhibiting the wonderful industries of the city; to the school board

of Iola, for the use of the high-school building for our meetings; and for the hearty hospitality extended by the citizens in general. We have enjoyed our visit. Long may Iola prosper. May her gas-wells never fail.

The treasurer reported a balance of $89.73 on hand at the beginning of this meeting. Report referred to the executive committee.

The secretary made a verbal report.

The report of the curator and librarian was read, and placed on file.

The committee on legislation was asked for a report. The secretary, being the only member present, gave an account of the efforts of the committee to secure legislation desired by the Academy, as expressed in the resolution passed at the last annual meeting. A discussion followed relative to the proper expenditure of our appropriation.

On motion of Professor Failyer, the executive committee was directed to confer with the Executive Council of the state to determine the relation of the Academy to the curatorship of the Goss ornithological collection, as a basis for action, and to report at the next annual meeting of the Academy.

The committee on nominations reported, recommending the following for officers for the ensuing year:

President, J. T. Willard, Manhattan.

First Vice-president, Edward Bartow, Lawrence.

Second Vice-president, J. A. Yates, Ottawa.

Secretary, G. P. Grimsley, Topeka.

Treasurer, E. C. Franklin, Lawrence.

On motion, the secretary was instructed to cast the ballot of the Academy in favor of these persons, and they were duly elected.

Moved by Prof. G. H. Failyer, that, in view of the wide-spread discussion concerning the presence or absence of gold in the western Kansas shales, the Academy appoint a committee of three to investigate the subject, and to report to the Academy at the next meeting. The motion carried. The president, appointed, as such committee, Geo. H. Failyer, J. T. Lovewell, and M. L. Ward.

The minutes of the meetings of the day were then read by the secretary, and approved.

On motion, the Academy adjourned *sine die*.

D. E. LANTZ, *Secretary*.

MINUTES.

Thirty-fifth Annual Meeting, Kansas Academy of Science, December 31, 1902, and January 1 and 2, 1903.

TOPEKA, KAN., December 31, 1902.

THE Kansas Academy of Science met for the thirty-fifth annual meeting at Topeka. The sessions were held in the new museum room of the Academy, in the state-house.

The Academy was called to order by President Willard at 7:30 P. M., December 31, 1902.

The following members were present at the opening session: E. H. S. Bailey, Edw. Bartow, Edw. Bumgardner, F. W. Bushong, J. C. Cooper, L. L. Dyche, G. P. Grimsley, A. W. Jones, D. E. Lantz, J. T. Lovewell, J. R. Mead, L. E. Sayre, B. B. Smyth, E. G. Smyth, L. H. Shattuck, A. J. Smith, C. H. Sternberg, J. T. Willard, L. C. Wooster, and J. A. Yates.

The secretary's report was read and accepted. It was as follows:

SECRETARY'S REPORT.

The secretary announces with pleasure that the Executive Council of the state-house has assigned permanent quarters to the Academy. These consist of a tile-floor museum room sixty-five by thirty feet, an office-room adjoining, in which the library is located. These rooms have been newly frescoed and painted, and cases have been provided for the library and collections.

A resolution of the Academy was adopted December 29, 1900, which urged "at as early a period as possible, the establishment and maintenance by the Academy of an economic museum of the industrial products of the state for popular instruction," . . . and held that "the collection for the museum of specimens other than those having a distinct industrial value should be for the present discouraged."

In accordance with this resolution, the secretary has installed in the new museum collections representing the mineral industries of Kansas. This has been made as complete as possible in the short time since the museum room was assigned to the Academy. This will be increased during the coming year, and promises have been made by a number of our mining companies to place fine and representative exhibits in our room.

The birds and animals formerly stored in this room have been placed, by order of the executive council, in the east wing of the building, in a room adjoining the Goss ornithological collection, all under the care of B. B. Smyth.

LIBRARY.—The Academy library is a valuable reference library for the state, and probably represents one of our best scientific libraries. We have on our exchange list a number of societies and individuals to whom we send our Transactions and receive nothing in return, and this too with societies which publish journals and reports. From some of our exchanges these reports come very ir-

regularly. Letters will be sent to these societies, and, unless satisfactory arrangements can be made, they will be dropped from our exchange list.

LEGISLATION.—Our Academy is a coordinate branch of the State Board of Agriculture, with which, I am glad to state, we are on the best of terms at the present time. I believe the time has come, however, for us to become a separate department in the state, and I hope the Academy will try and secure a law to this end. I would suggest that one of the duties of the Academy under this new law be the publication of an annual bulletin on our mineral resources, which would make the Academy one of the practical state departments as well as purely scientific. We would sacrifice nothing and gain much valuable support.

MEMBERSHIP.—By-law V of our constitution states that "Members who shall allow their dues to remain unpaid for two years, having been annually notified of their arrearage by the treasurer, shall have their names stricken from the rolls." With the consent of the treasurer, I have sent out notices of the amount of dues unpaid to the members, and returns are coming in; but some of the people seem to be lost, as the letters are returned uncalled for. Some of the names on our rolls as members have never qualified. It does not seem just that those who have not qualified and who are behind in dues several years should have the same benefits of receiving the Transactions as those who pay each year. The trouble, in part, has been the failure to notify these persons of their indebtedness.

POLICY.—The secretary is endeavoring to place the Academy on a business basis, and to run the office on that plan. As rapidly as possible the property of the Academy is being arranged in a systematic way in the rooms and is being classified. Property which has accumulated and is of no direct value to the Academy is being thrown out. Efforts are being made to keep the exchanges in complete files, and missing numbers will be obtained as rapidly as possible. An effort will be made to secure a complete list of the science teachers and others interested in science work. If we are going to make this institution a success, every member must do his or her part, aid in securing new members, keep up their dues, and say good words for the Academy. Now is the time for this work, and let each and every one do his part. G. P. GRIMSLEY, *Secretary.*

On motion of Professor Sayre, the recommendation in report of the secretary referring to legislation was referred to a committee. The president appointed F. O. Marvin, G. P. Grimsley, A. W. Jones and E. A. Popenoe as members of this committee.

Moved and voted that a special committee be appointed to consider the secretary's report, except the section on legislation, already provided for. The committee was appointed, as follows: L. E. Sayre, D. E. Lantz, and J. T. Lovewell.

In the absence of Treasurer Franklin, Prof. E. H. S. Bailey was appointed acting treasurer.

Prof. L. E. Sayre was appointed as a committee on press reports.

The following committees were also appointed:

On program: G. P. Grimsley, F. W. Bushong, and A. J. Smith.

On membership: Warren Knaus, E. H. S. Bailey, and J. A. Yates.

On necrology: D. E. Lantz and B. B. Smyth.

On nominations: L. E. Sayre, E. A. Popenoe, and J. R. Mead.

On resolutions: L. L. Dyche and J. T. Lovewell.

The special committee on the investigation of the presence of gold in Kansas shales, in the absence of the chairman, G. H. Failyer, made only a partial report.

The committee on the relation of the Goss collection curatorship to the Academy reported, through Professor Willard, that the attorney-general seemed to recognize the power of the Executive Council of the state to appoint the curator, and they had already done this.

The following papers were then read:

1. Notes on the food habits of California sea-lions, by L. L. Dyche.

2. Loss of teeth as a disqualification for military service, by Edw. Bumgardner.

The committee on membership recommended the following eighteen persons for new members of the Academy: Harvey W. Baker, Topeka; Dr. Clarence L. Cole, Topeka; F. B. Dains, Topeka; John J. Jewett, Topeka; Pres. Norman Plass, Topeka; S. F. Poole, Wichita; C. L. Pribble, Topeka; J. L. Shearer, Halstead. Also the following, who were not present at the meeting: Dr. G. W. Hoxie, Lawrence; W. F. Hoyt, Salina; Elmer V. McCollum, Lawrence; Dr. J. M. McWharf, Ottawa; Dr. H. M. Moses, Salina; W. H. Olin, Ames, Iowa; W. H. Rice, Richmond; Miss Lumina C. Riddle, Columbus, Ohio; Arthur Ringer, Effingham; J. H. Schaffner, Columbus, Ohio. These persons were then elected members.

On motion, the Academy adjourned, to meet at nine A. M., January 1, 1903.

THURSDAY MORNING, January 1, 1903.

The Academy met in the museum room, and was called to order by President Willard.

The minutes of the preceding meeting were read and approved.

Committee on program recommended a selection of titles from the different groups on the printed program.

Moved and voted that a committee of three be appointed to determine the place for next meeting. The president appointed Warren Knaus, Edward Bartow, and J. A. Yates.

It was voted that the papers of members not in attendance be read at the option of the president, if there was time and suitable opportunity.

The reading of papers was then continued:

3. Additions to the list of Kansas Coleoptera for 1901–'02, by Warren Knaus.

4. On the alkyl sulphates, by F. W. Bushong.

5. Further notes on loco weed, by L. E. Sayre.

6. A study of dietaries in Lawrence, Kan., by E. H. S. Bailey.

OFFICE AND LIBRARY OF THE KANSAS ACADEMY OF SCIENCE,
Capitol Building, Topeka.

7. The flora of Kansas, by B. B. Smyth and J. H. Schaffner. (An outline of the paper was given by B. B. Smyth.)

8. A provisional list of the Uredineæ of Bourbon county, Kansas, by A. O. Garrett. (In the absence of the author, this paper was read by title.)

9. Experiences with early man in America, by Chas. H. Sternberg.

An auditing committee was appointed, consisting of Edw. Bartow and C. H. Sternberg.

The Academy then adjourned, to meet at two P. M.

THURSDAY AFTERNOON, January 1, 1903.

The Academy met in the usual place, with President Willard in the chair.

Prof. E. H. S. Bailey, as acting treasurer, reported a balance in the treasury of $117.43, without including the dues paid at the present meeting. The report was referred to the auditing committee.

It was moved and voted that a sum not to exceed fifty dollars be allowed by the Academy for illustrations for the next volume of the Transactions.

A report on the proper acceptance by the Academy of the Quintard conchological collection was made through Prof. D. E. Lantz. It was voted that a written report be filed for record. The report was as follows:

The minutes of the proceedings of the meeting of the Academy held at Topeka December 29, 1900, show that an announcement was then made to the effect that the Quintard collection had come into the custody of the curators of the Academy, to be exhibited in the state museum, after which this committee was appointed. This announcement was made by the then acting curator, B. B. Smyth, who now explains that the collection is held by him under a receipt as follows:

"SILVER LAKE, May 31, 1900.

"This is a receipt for the Quintard conchological collection of shells, donated by the heirs of J. B. Quintard to the state of Kansas, to be arranged and displayed and properly cared for in the museum at the state-house, in Topeka, on condition that it be added to or subtracted from on penalty of forfeiture and of being reclaimed by the legal heirs of J. B. Quintard. (Signed) B. B. SMYTH."

Mr. Smyth also explains that he was in error in the sketch of Mr. Quintard in our last volume of Transactions, in saying that the heirs had given the collection to the Academy.

Your committee, therefore, state that the collection has not been tendered to the Academy, that it is not now in the custody of the Academy, and there is, therefore, nothing for this committee to accept.

D. E. LANTZ, *Chairman.*
E. A. POPENOE.
B. B. SMYTH.

The report was accepted and the committee discharged.

It was moved and voted that a copy of the report be sent the Quintard heirs.

The committee on membership recommended the following persons for membership, and it was so voted: Miss Edith A. McIntyre, Manhattan; H. I. Woods, Topeka; F. B. Isely, Wichita; Pierce Larkin (not present), Norman, Okla.

The committee further recommended, and the Academy elected, the following persons as life members, when they complied with the conditions of the constitution: F. O. Marvin, Lawrence; L. E. Sayre, Lawrence; Warren Knaus, McPherson.

Prof. S. W. Williston, of the University of Chicago, was elected an honorary member of the Academy.

The committee presented memorials on Dr. Geo. T. Fairchild, Col. N. S. Goss, and Davis A. Boyles.

Moved and voted that the report be accepted, and the memorials be published.

Committee on secretary's report, through Prof. L. E. Sayre, moved the report be adopted and the same be spread upon the minutes, and it was so voted.

The committee on portion of secretary's report referring to legislation reported as follows:

1. That in the opinion of the committee it is inadvisable at the present time to ask for any change in the relation of the Kansas Academy of Science to the state.

2. That if legal steps, such as a legislative act or action of the Executive Council of the state are found to be needed to place the Goss ornithological collections under the control of the Academy of Science, the executive committee of the Academy be instructed to take such steps at once.

The report was adopted.

The reading of papers was then resumed:

10. On the action of the acid reagents on the substituted ureas, by F. B. Dains.

11. Gold in Kansas, by J. T. Lovewell.

12. The eleven and one-half inch equatorial of the Washburn College observatory, by H. I. Woods.

The committee on nominations recommended the following officers for the year:

President, J. C. Cooper, Topeka.

Vice-presidents, Edward Bartow, Lawrence; J. A. Yates, Ottawa.

Treasurer, Alva J. Smith, Emporia.

Secretary, G. P. Grimsley, Topeka.

It was voted that the president cast the vote of the Academy for these officers, and the vote was cast.

The Academy then adjourned, to meet at eight P. M.

THURSDAY EVENING, January 1, 1903.

The meeting was called to order in the Academy rooms by Vice-president Edw. Bartow.

President Willard then delivered his presidential address on the subject "The Limitations and Mission of Science."

At the close of the address the reading of papers was continued:

13. Statistics relating to Kansas birds, by D. E. Lantz.

14. The extent and thickness of the Oklahoma gypsum, by C. N. Gould.

15. Determination of oaks by chemical analysis of the ash, by E. B. Knerr.

16. The Coleoptera of Kansas—the families Cicindelidæ, Scydmænidæ, and Pselaphidæ, by Warren Knaus.

17. Examination of some Kansas petroleum, by Edw. Bartow and E. V. McCollum. (Read by Edw. Bartow.)

The Academy, on motion, adjourned at ten P. M., to meet Friday morning at 8:30.

FRIDAY MORNING, January 2, 1903.

The Academy met in the museum room, with President Willard in the chair.

The minutes of the preceding meetings were read and approved.

It was voted that all papers for publication should be placed in the hands of the secretary by the middle of the next week, and those papers not so placed be left over until the next volume.

Committee on place of next meeting reported in favor of Manhattan or Salina as the place.

Moved the report be received, and Manhattan be the place of meeting. An amendment to substitute Salina was lost, and the original motion was carried.

Committee on resolutions had no report to present.

W. A. Harshbarger, Topeka, and H. T. Martin, Lawrence (not present), were elected members of the Academy. This made twenty-four new members elected. In all, there were thirty-eight new and old members present at the meetings, and, in addition, a number of visitors.

It was voted that J. R. Mead be made a committee of one to collect photographs of members of the Academy, for preservation at the office of the Academy.

It was moved and voted that a committee be appointed to draft suitable resolutions to show a recognition of the kindness of the Executive Council of the state in assigning the Academy new quarters. Referred to L. L. Dyche and J. C. Cooper.

It was voted that a limited amount of money be expended for completing the files of serial publications in the library.

The reading of papers was then resumed:

18. Further studies in the Dakota and Mentor beds, by A. W. Jones.

19. Coleoptera of the Sacramento mountains of New Mexico, by Warren Knaus.

20. Crystalline liquids, by Fred S. Porter. (Abstract read by Edw. Bartow.)

21. Physical tests applied to gypsum wall plasters, by G. P. Grimsley.

22. A new condenser for preparing distilled water in large quantities, by J. T. Willard.

23. Food habits of the common garden mole, by L. L. Dyche.

Dr. F. H. Snow presented abstracts of his papers:

24. Some notes on the birds of Kansas.

25. The insects of Hamilton and Morton counties.

26. A collecting trip to central Arizona.

The following papers were then read by title:

27. A new species of fish, by F. F. Crevecœur.

28. Exotic Coccidæ, by S. J. Hunter.

29. Artificial parthenogenesis induced by solutions concentrated by evaporation, by S. J. Hunter.

30. Analysis of some Oklahoma salt and gypsum waters, by R. S. Sherwin.

31. Ionic velocities in liquid ammonia solutions, by E. C. Franklin and H. P. Cady.

32. Hydrofluoric acid as an electrolytic solvent, by E. C. Franklin and H. P. Cady.

33. The liquid-air plant at the University of Kansas, by E. C. Franklin.

34. Further conductivitv measurements of liquid ammonia solutions, by E. C. Franklin.

35. The log of the Winfield gas-well, by R. B. Dunlevy.

36. List of fossil plants collected in the vicinity of Onaga, by F. F. Crevecœur.

37. Notes on the fossil mammoth from near Winfield, by R. B. Dunlevy.

38. Notes on the geology of Antelope hills, by R. S. Sherwin.

39. A contribution to the medicinal plants of Kansas from an economic point of view, by L. E. Sayre.

40. A review of the weather during the crop season of 1902, by T. B. Jennings.

41. Springs of Woods county, Oklahoma, by Pierce Larkin.
42. Preliminary list of Diptera of Kansas, by F. H. Snow.
43. Notes on the geology of Wichita, Kan., by C. N. Gould.
44. The asphalt mines of the Indian Territory, by C. N. Gould.

The committee on resolution drafted for the Executive Council reported the following, which was adopted:

Resolved, That the thanks of the Academy be extended to the Executive Council of the state for furnishing the Academy with the comfortable quarters we now enjoy. It will add very materially to the standing and usefulness of the Academy.

It was moved and voted that the secretary be instructed and provided with funds for preparing a directory of all science teachers and investigators in the state.

The minutes of this meeting were read and approved.

The Academy then adjourned *sine die*.

G. P. GRIMSLEY, *Secretary*.

ADDRESSES DELIVERED AND PAPERS READ

BEFORE THE

KANSAS ACADEMY OF SCIENCE,

AT

IOLA, 1901.

TOPEKA, 1902.

I.—Presidential Addresses.

II.—Chemical and Physical Papers.

III.—Geological Papers.

IV.—Biological Papers.

V.—Miscellaneous Papers.

VI.—Necrology.

VII.—Announcements, Library Accession List, and General Index.

I.

PRESIDENTIAL ADDRESSES.

"SCIENCE AND THE NINETEENTH CENTURY."
By PROF. EPHRAIM MILLER, of the University of Kansas, Lawrence.

"THE MISSION AND LIMITATIONS OF SCIENCE."
By PROF. J. T. WILLARD, of the Kansas Agricultural College, Manhattan.

SCIENCE AND THE NINETEENTH CENTURY.

By EPHRAIM MILLER, of the University of Kansas, Lawrence.

An address delivered at Iola, December 31, 1901, before the thirty-fourth annual meeting of the Kansas Academy of Science.

AT the Battle of the Pyramids, July 21, 1798, the "Man of Destiny" said to his soldiers: "Forty centuries are looking down upon you." In this, the first year of the twentieth century, we need not look back so far to arouse us to action. One hundred years of strenuous life, full of splendid achievement, the nineteenth century is incomparably the most illustrious of all the centennials of time. Its record, from start to finish, is marked by years of substantial growth and progress. It is a century of coal, iron, and steel, of steam and electricity—one in which the human mind has cut loose from the dead weights of the past, to be evermore free from tradition and superstition. Along all avenues of human activity—literature, science, art, architecture, government, trade and commerce, engineering, medical and surgical science, law and theology—the steps of a giant are to be seen.

Eighteen centuries did not accomplish, in the aggregate, what the imperial nineteenth has; nay, even the forty centuries of Napoleon fall far short of it. "From the earliest historic times certainly, if not from the dawn of primitive humanity, down to the present day, the problem of the universe has been the most attractive and the most illusive subject of the attention of thinking men. All systems of philosophy, religion and science are alike in having the solution of this problem for their ultimate object."

The problem is still unsolved. Man at a very early period began to investigate, and in the infant years of his existence "devised three distinct methods" that are, even in our day, persisting with equal tenacity. The first of these is the *a priori* method. It reasons from the subjective to the objective. It requires neither observation nor experiment on the external world. The second is known as the historico-critical method. It depends on tradition, history, direct human testimony, and verbal congruity. It limits observation and experiment to human affairs. The third is the method of science. It begins, in its elements, with observation and experiment. Its early applications were limited mostly to material things. In its subsequent expansion it has gained a footing in nearly every field of thought.

The first has been used by dogmatists, especially the founders and advocates of all fixed creeds, from the atheistic and the pantheistic

to the theistic and the humanistic; the second has been used by historians, publicists, jurists, and men of letters; and the third by scientists, astronomers, mathematicians, physicists, naturalists, and, more recently, by anthropologists. The great schools of philosophy and theology of Babylon and Chaldea, of China and India, of Egypt and Athens, could not solve the problem of the universe; man remained essentially barbarian. The story of the first sixteen centuries of the Christian era reveals decaying empires, vice in its most hideous forms, crime of the most appalling character, ignorance and brutality, Neros and Caligulas. Here and there a dim light might be seen. In 1257 Roger Bacon was sent to Paris, where he was closely confined for several years, because he had ventured to attack the old philosophy. In 1592 Bruno was burned for his denunciation of Aristotle, and his advocacy of truth, lead where it might. In 1633 Galileo was forced by the inquisition to abjure the Copernican theory. Ostracism, torture, fire and death were the rewards that men of science received in those days. The common notion was that a laboratory was a place in which the truth-seeker was supposed to receive help and inspiration from the devil. Free thought was heresy, and to investigate nature's mysteries was a diabolical crime.

Discouraging as all this was to men of science, nothing could prevent the onward movement that had already been made. The fall of Constantinople in 1452; the discovery of the art of printing in 1456; the gift of a new world to mankind in 1492; the publication of the Copernican system of astronomy in 1543; the invention of the telescope by Galileo in 1609, with which he discovered the moons of Jupiter and the rings of Saturn; the announcement of Kepler's three laws of planetary motion in 1609 and 1618; the immortal works of Sir Francis Bacon at the beginning of the seventeenth century, in which he did not hesitate to ridicule the philosophy of Aristotle, on the ground, first, that it yielded no fruit, second, that its only service was for useless disputation, and third, that the end it proposed was a mistaken one; the discovery, in the seventeenth century, of the calculus, the most powerful instrument of calculation in the whole range of mathematics; the announcement by Newton in 1685 of the universal law of gravitation; the discovery of oxygen by Priestley in 1774, and the creation of the science of modern chemistry by Lavoisier, were the principal steps taken, few and far between, in order to reach the majestic work of the nineteenth century. Poetry and art, literature and theology, politics and war, were the chief factors in the world's life.

Books and libraries were to be found in the monasteries and in possession of royal families. They were not for men at large. Their

civilizing and refining influences failed to reach the masses. Look at Italy, under her reigning popes and princes, talented, learned, and scholastic, and in possession of the best literature and art of the ages; look at France and Spain and Germany, too, with their Bourbons and Charles the Fifths; look at England, under her Roses, Plantagenets, and Stuarts—how much advancement was made by those nations in a thousand years? Villari, an Italian historian, in his "Life and Times of Savonarola," gives a glowing picture of Lorenzo de Medici, ruler of the city of Florence from 1469 to 1492. He says, in his first volume, that Lorenzo "was the typical man of his age—all his qualities were confined to his intellect; his courteous manners were the result of mental refinement, not of kindness of heart; his patronage of the learned was born of his passion for culture, and also because he found it a pleasant pastime, and one useful to his influence as a ruler. After hours of strenuous labor over some new law framed to crush any lingering remains of liberty, or after passing some new decree of confiscation or sentence of death, he would repair to the Platonic academy and take part in heated discussions on virtue and the immortality of the soul; then go about the town to sing his ribald songs in the company of dissolute youths and indulge in the lowest debauchery. After this he would return home, receive great scholars at his table, and vie with them in reciting verses and discoursing on the poetic art. All literary men of any note in Florence gathered round Lorenzo. And both at the meetings held in his own house and those of the renowned Platonic academy, his genius shone amidst this chosen band, while his literary culture gained no little nourishment from their intercourse." Under him Florence "was a continuous scene of revelry and dissipation." "What was most visible at the time was the general passion for pleasure, the pride of pagan learning, the increasingly sensual turn, both of art and literature, under the fostering hand of the man who was master of all in Florence."

What the historian has depicted in such glowing language as being true in Florence was more or less true of many other cities of Europe. All ranks of society, with glorious exceptions here and there, were in a frenzied condition, gone mad with revelry and rottenness. The centuries came and went, and still the pall of the ages hung over man, with but few signs of ever being lifted. Herodotus and Homer, Socrates and Plato, Praxiteles and Phidias, Virgil and Horace, and other mighty names in poetry and art, were read and admired and exalted to the heavens in the midst of revelry and debauchery.

The end, however, was coming. Near the close of the eighteenth century two almost contemporary events occurred. Like a flash of lightning from a clear sky they startled thinking men. These were

the American revolution, and the French revolution of 1793. No more tradition, no more Aristotle, no more hair-splitting casuistry of the churchman. The imperial power of science and the laboratory was henceforth to change this old world. The sovereign century had come, and man the sovereign had also come. The horizon of human life, thought and activity has been widely extended since the world discovered a hundred years ago that "the great forces of nature are neither sacred nor profane, neither kind or cruel; that they neither love nor hate, and that they are more unchangeable than the stars; that shrines and temples, priests and priestesses, tripods and oracles, have been in vain, except so far as they reached the human heart and satisfied its natural craving for the worship of the Supreme Being. Instead of building a temple to the far-darting Apollo, or to Zeus, the thunderer, we now stretch over our cities a network for artificial lighting; and all the winds that blow and all the waters that flow are made to furnish their tribute to our comfort and pleasure. We tap the sources of endless energy and transmit it through all the ramifications of our social order, relieving mankind from heavy burdens and creating hundreds of occupations hitherto unknown." A change of front has taken place all along the line. This does not mean that the past is to be buried in oblivion by any means. All that has come to us out of the past that is permanently fine and essential to high thinking and well doing, the epics of Homer, the philosophy of Plato, the splendid drama of Job and the Psalms of David must continually "live, imperishable monuments of the youth of the world."

Let Aristotle go; let the hair-splitting casuistry of the schoolmen be forgotten; let the hide-bound dogmas of the old theologians be cast to the moles and the bats; our modern life stands for the best, and our intellectual activities give promise of still nobler things. "The defenders of the Johnsonian programs delight in the use of unworthy epithets with which to characterize the tendency of modern education; they plead for *humanities* as though anything human was foreign to our curriculum." What can be more human than human life as we see it and as we share it? What problems can be more human than those which face nine out of ten of the people who reach the age of individual responsibility?

Francis A. Walker, late president of the Massachusetts Institute of Technology, in his remarks at the dedication of the new science and engineering buildings at McGill University, Montreal, said:

"The notion that scientific work was something essentially less fine and high and noble than the pursuit of rhetoric and philosophy, Latin and Greek, was deeply seated in the minds of the leading educators of America a generation ago. We can hardly hope to see that

inveterate prepossession altogether disappear from the minds of men who have entertained it. Probably they will have to be buried with more or less of their prejudices still wrapped about them, but from the new generation scientific and technical studies will encounter no such obstruction, will suffer no such disparagement. Let us now consider for a few moments the story of the nineteenth century, and as the picture passes before our eyes accord to it the honor due to such splendid achievements.

The one great, masterful event that came in with the nineteenth century was the invention of the steam-engine. This marvelous machine, for the space of a hundred years, has been one of the masterpieces of scientific thought. It is the force that propels thousands of floating palaces over all the waters of the world; that transports the commerce of continents from ocean to ocean; that handles machinery so deftly that a hundred thousand separate and distinct parallel lines can be engraved upon an inch of highly polished steel; that furnishes to the busy world one hundred thousand horse-power; that runs countless looms and mills, furnaces and factories. It annihilates time and space, and gives to the laboring man full employment. The benefits that have accrued to the race from the use of the steam-engine are beyond computation. Closely connected with it is the man who stands by its throttle, the engineer. Go where we may, upon land and upon sea, and in the bowels of the earth, there you will find him—a man of science, an inventor, a whole-hearted gentleman. Look at his achievements! See the transformation produced by the Suez canal in the shortening of the paths of commerce and of travel, and the comforts accruing therefrom. Imagine, if you please, the wonderful impetus that will certainly be given to all the interests of the great republic, by the construction of the Nicaragua canal. An American engineer will, ere long, do it. Consider, for a moment, those triumphs of engineering skill, the great steel bridges, the cantilever bridges, the tunnels that perforate mountain barriers, and the ocean greyhounds, surpassing all the wonders and splendors of ancient Carthage, Egypt, and Athens. Every enterprise of the engineer, whether the construction of a bridge, of a tunnel, of a ship, of a house of twenty-five stories with its steel frames, or of a Corliss engine, is an advance agent of prosperity, progress, and peace. Homer, Shakspere, or Milton, Balzac, George Eliot, or Thackeray, cannot inspire one with beautiful thoughts or purify the fountains of life more than can a Corliss engine at work with its ponderous machinery, and silently, mysteriously and with the least possible friction doing its work, and turning out products of unsurpassed variety, beauty, texture, utility, and value. Here, surely, is a civilizer as potent as anything that ever came from poet's brain or novelist's dreams.

The science of chemistry is another of the great factors of human progress, a veritable child of the nineteenth century. Chemical analysis stops at no obstacle, shrinks from no difficulties, examines what we eat and tells us what we shall drink, liquifies common air, pronounces upon the purity of drugs, unravels the mysteries of nature, and blesses mankind in all the functions of life.

The medical practitioner has need of the chemist. The lawyer summons to his aid the chemist to unravel the difficulties of criminal jurisprudence; chemists for the mines, for the sugar-mills, for the manufacture of colors; chemists for everything.

In the problem of life upon earth, chemistry has become the handmaid of nearly all the other physical sciences. Physics, astronomy, biology, botany, and that most bitterly fought of all modern theories, evolution, are more or less indebted to chemistry for the firm foundation upon which they rest.

What would now be thought of an instructor in science advising his students to shun the writings of Darwin as false and dangerous? Yet not many years ago such was the case. The theory of evolution is an established fact. It teaches in no uncertain way, and beyond controversy, that the survival of the fittest is a law established by the Almighty that is as regular and immutable as that other law, that the attraction of two bodies varies directly as their masses and inversely as the squares of their distances. "The Origin of Species by Natural Selection," announced by Darwin in 1863, proved, as well as anything can be proved, the variations in species, and at the same time pointed out their causes. By a single stroke, the old theories of special creations and cataclysmal changes in the crust of the earth were pushed aside to give way to a philosophy based upon true scientific lines. Closely associated with chemistry and evolution—and a child of the nineteenth century also—is the science of biology, another term that has been held up to ridicule and derision; and yet it has been established beyond doubt by microscopical analysis that all organic life, whether animal or vegetable, is the result of cells, and that protoplasm is identical in plants and animals. At this point biology receives help from the chemical laboratory. Infinitely little things as well as infinitely large ones are examined with attention and profoundest thought; and it is all done, not in the interest of controversy, but that the truth may be reached. The microbe, the cell, the atom, the light from a distant star, the composition of the star itself, the number of vibrations of light, of heat, of sound, and the very essence of things, are studied by the scientist of all lands. Countless millions of stars are added to the galaxy, the parallaxes of stars are measured, and the size and velocity of atoms of gas are estimated with a degree of certainty that is marvelous.

"The middle ages covered Europe with cathedrals of unsurpassed beauty and grandeur, but made no new discoveries to lighten the toil or increase the comfort of the race." Only about ten practical discoveries and inventions of the first magnitude were made from the dawn of history to the beginning of the nineteenth century. These were alphabetical writing, Arabic numerals, printing, the barometer and thermometer, the mariner's compass, the telescope, the steam-engine, which belongs more properly to the nineteenth century, gunpowder, the screw, and the wheel. To the nineteenth century eighteen such inventions and discoveries belong—railways, steamships, electric telegraphs, the telephone, Lucifer matches, gas illumination, electric lighting, photography, the phonograph, the Roentgen rays, spectrum analysis, anesthetics, antiseptic surgery, vaccination, the cotton-gin, the typewriter, the sewing-machine, and the self-binding reaper. To these may be added Pasteur's solution of the process of fermentation, the various methods employed in the liquefaction of gases by intense cold, the organization of great hospitals, public and private, conducted upon the most highly approved scientific and sanitary principles, great schools for the scientific study of poverty and crime, discoveries along geographic and geologic lines, and the complete transformation from the old methods to the modern laboratory method. Such is a part of the inheritance bequeathed to the twentieth century by the demise of the nineteenth. The laboratory is the great revealer. Out of it comes the truth. Under its relentless power error and superstition are crushed. History, literature, metaphysics, and art, poetry and theology, even science itself, must submit to the keen scalpel of the laboratory. According to one writer, the "philologist must have the aid of the physiologist to unravel the problem of human speech; the philosopher, also, in order to explain the workings of the human brain." "With pick and shovel the archæologist has brought to light the ancient civilization of Egypt, and the implements of primitive man." "He has dug out the Ilium of Priam, and laid bare the Roman forum, and read from the clay tablets the language of the Assyrians." By him the history and life of the mound-builders and cliff-dwellers of North America are coming to the light.

In literature, also, the century stands unrivaled. With perhaps the single exception of poetry, there is nothing in the past that can approach in beauty, purity, diction and style the prose, the philosophy, the romance and the history of the writers of the nineteenth century. Such singular preeminence is not to be found in any of the writings of previous centuries. What has caused such a marvelous

change? The answer is easily given. The laboratory method, supplemented by scientific criticism.

Eighteen centuries were devoted to the classics of Athens and Rome, the philosophy of Aristotle, and the controversies of the schoolmen, and yet how slow were the steps of progress, how comparatively fruitless the results! To be sure, the world would be a loser if the masterpieces of ancient literature and their benign influence upon the thought and life of succeeding ages were blotted out of existence. The great schools of this country are widening their curricula immensely, especially in the direction of the sciences. The number of students devoted to the pursuit of special and general scientific culture shows most conclusively that "the exalted character of a man's work is to be measured by its usefulness to mankind." Changing the language somewhat, an eminent scientist and scholar has said that "the scientist is by nature an iconoclast. He has small respect for the traditions. He bows not down to the 'tyranny of the ancients.' His glories are in the future. He looks forward, not back. He does not hesitate to smile at the puerile fancies of people who created gods and demigods in order to account for phenomena which to-day submit to mathematical analysis, and which bear no comparison with the exploits of modern science. The accomplished scientist generally reciprocates such prejudice, for he cannot understand how the worship of the ancients can be really serious; it seems to him three-fourths affectation." Technical, scientific and liberal branches in the past have been separated. Now they work side by side, each rendering the other valuable assistance. Science has revolutionized the old and effete systems, and opened wide the door of knowledge and of life.

In the heavens, in the earth, air, and sea, above, below, around, everywhere, science has cast her keen, observing eyes; intelligence has multiplied beyond all computation; the comforts and conveniences of life have increased a thousandfold; nature has been compelled to yield wealth, health, strength, and power, and a better and sweeter life from thousands of fountains that had never before been opened and whose existence had never been dreamed of.

Science is the great truth-seeker, the great truth-finder. The record of the nineteenth century is closed, but some of its problems are still waiting for solution. Will the new century meet the problems and answer them? Will not chemistry, biology, evolution, physics and astronomy bring to the light a marvelous array of new principles and facts not yet dreamed of? Already the answers are coming—are here. A Frenchman has built a machine by which he has shown beyond doubt that aerial navigation has at last been accomplished. Not long will it be until the American will be able to enter his aerial ship

from his front door-step and cross to Europe in two or three days. An Italian has caused the telegraph companies of to-day to shake with fear at the bare suggestion of wireless telegraphy.

How long will it be before we shall communicate with the people of our neighboring planet, Mars?

Who, in the light of the past few years, does not see in the electrical appliances of to-day the promise of immensely greater results? Is it not possible that electricity may be the cause of light, heat, and ethereal vibrations, and of all chemical and physical forces?

May not the play of electricity extend from sun to planet, from star to star, changing nebulæ into stars, and stars back again to nebulæ?

But who can peer into the future? Who reveal the secrets that science will bring to light in the next hundred years?

Out of the universal matrix will come knowledge resplendent with honor and glory. The Almighty has so ordained it, and in His own good time His omni-science will bring to view the hidden mysteries of nature.

THE MISSION AND LIMITATIONS OF SCIENCE.

By J. T. WILLARD, of the Kansas State Agricultural College, Manhattan.

An address delivered at Topeka, January 1, 1903, before the thirty-fifth annual meeting of the Kansas Academy of Science.

IT is not my purpose to attempt to trace the development and influence of science from its origin to the present time. This would, at best, be largely speculative. I wish, however, at the outset to define the domain of science, so that our thoughts may be directed in the same channels. We all have some idea, it may be more or less vague, as to what is meant by the term "science," but its definition, I fancy, is not easy to any one. I question if any of the body of workers commonly called scientists would call mathematics a branch of science, as the term is now generally used, although in no branch of learning is there possible such absolute logic and systematic arrangement of the material under discussion, and the dictionary defines mathematics as the science that treats of quantity. Mathematics, however, deals with the abstract. It is the product of intellect working upon itself. While it is applied and is of the most transcendent importance to the concrete operations of every-day life and the sciences, it does not essentially deal with the concrete, unless it be true that the axioms of mathematics, which constitute the unprovable bases of assumption upon which its magnificent superstructure is reared by successive steps of pure logic, are themselves but statements of concrete experiences of man in his contact with nature, which have by their unvarying associations become so impressed upon the organization, that all agree that to deny them is an absurdity. Be that as it may, mathematics is essentially a matter of pure intellect, and does not come in the field of learning that is included within the term "science" as it is most frequently heard.

Science deals with facts—that is, occurrences that are matters of observation. It is concerned essentially with the concrete, and with pure reasoning directly applied to the concrete. History considered merely as a record of events or facts is not science. Neither is literature, though it may be rich in facts. As I conceive it, science is the study of occurrences or phenomena of nature in their relation to each other. The study of the relations among facts constitutes the essence of science. When we speak of "the sciences" we must understand that this is merely for convenience. The sciences are but sections, more or less distinct, of science, and in truth the more we learn of the sciences the less distinct they become, and the more and more they merge into the all-inclusive unit, science, which is knowl-

edge systematically arranged, so as to display what we are pleased to call the laws of nature, though more fittingly designated as the order of nature. Science is a continuous study of antecedents and consequences, causes and effects, interrogation and reply, action and reaction, the source and outcome of every change. It is the intellect applied to matter and energy.

All through the ages man has been slowly acquiring the knowledge that makes the warp and weft of science. Much of this has been beaten into him by Dame Nature with her kindly but unchanging order. "The soul that sinneth it shall die," "Hear and your soul shall live," are truths that the eons have been teaching man. The seeming harshness of the first is but one side of the shield; and while the punishment that nature gives ignorance and foolishness is inexorable, it is really but another manifestation of the constant faithfulness which follows seed-time by harvest, and in so many ways gives forethought a richer reward. When man first recognized an item in the order of nature, science was born; when he first utilized that knowledge to ameliorate his condition, civilization was born. The growth of both was extremely slow. Truth may be likened to a great sphere of crystal which must be picked to pieces. As long as it presents its smooth surface but little hold can be gained and progress made. One must with great labor and slowly go down deeply at some point, or excavate a trench from the sides of which rapid progress may be made. So with science, the more we learn the more we can learn; but the beginnings of knowledge came with such painful slowness that there can be no doubt that thousands of years were required to make known what seem to us fortunate "heirs of all the ages" as very simple things. The acceleration in the rate of acquisition of knowledge of nature's order was slow, and it is safe to say that more was learned during the last century than during all time before.

Modern civilization is the product of science. It is the direct result of the partial discovery of the laws of nature that we have thus far attained. The future of civilization is inseparably bound up with the progress of science. As yet only the simpler relations of matter and force are at all thoroughly understood, and in the more complex relations, involving life and the relations between living things, we have scarcely made a beginning. I shall not take your time to enumerate the stock illustrations of the progress of the nineteenth century; the newspapers do that for us, and it may be safely assumed that they are familiar to all, though I believe that they are taken so much as a matter of course that the younger ones of us do not realize how tremendous the change has been. I wish, however, to call your attention to one or two phases of this growth of civilization.

First, this entire progress in the mastery of nature and in directing her forces is a triumph of reason, of intellect. Intellect to many seems cold, devoid of feeling, knowing neither pleasure nor pain. To some, reason seems antagonistic to love and reverence. We all live and work for happiness, present and future. Whether we have analyzed our motives or not, whether we understand ourselves or not, that is our object. The channels through which it reaches us are many and diverse—some are more open with one, others with another; but I wish to insist that, so far as those due to civilization are concerned, intellect must be given the credit. I do not for a moment underrate the place that physical pleasures fill in making life worth living. The desire to gratify them often serves as a stimulus to intellectual effort, and thus they may at times even accelerate material progress, but they are not as a rule directly productive of it. The delights of the senses, while so alluring as to become the sole aim of many, are in themselves non-productive. Reason must be the great producer, and more than that, she must ever stand as the inflexible guardian of her products. Without her stern protection, the temptation to present pleasure would dissipate past accumulations and destroy future possibilities. By means of the intellect the pleasures of the average individual to-day exceed those of ancient kings. Means of transportation and communication alone have multiplied them many fold. The sublime beauties of mountain, plain and sea may be enjoyed by hundreds instead of one. Through modern machinery, the perfection and wonderful accomplishments of which are almost incredible, the ordinary home possesses equipment, beauty and comfort exceeding that of Solomon's palace. I will not enter into further detail, but if you will think the matter out you will see that most of our pleasures, and especially the great abundance of them, are due to the dominance of reason—that is, the dominance of science.

Appreciation of the value of science in every-day life is shown in the establishment of technical schools and their growing favor with the people. It is also shown by the establishment, under federal patronage, of an agricultural experiment station in each state, in which the resources of science are brought to a direct bearing upon the problems of plant and animal production, with their many ramifications into the realms of chemistry, physics, physiology, biology, geology, and engineering. The growth of nature study in the schools is another indication of the appreciation of science, though doubtless this movement may at times degenerate to the level of a fad. Agitation has begun, and will continue to some tangible result, looking to the teaching of the simple scientific principles of agriculture in the common schools of the country. The art of cooking, now taught in so many schools

and destined to be introduced far more extensively, is not imparted merely as a series of rules, but with the reasons for procedure explained upon chemical, physical and physiological principles. Schools of mechanical, electrical and mining engineering are monuments to the confidence of the people in training in science.

Science has revolutionized education. I have not the time now, nor indeed the detailed information necessary, to prove this, but it is more or less a matter of common knowledge that not so long ago a classical education was the only one available, and law, medicine and theology the sole occupations of men of education. The intellectual training that the classical education gave and the culture that it imparted are undoubtedly of great value, but with the swift pace of modern times, and the important part that science plays in so many walks of life, the demand has arisen and been met for an education to the useful. In this, time has frequently been shortened, and culture as such curtailed, perhaps to too great an extent, but the chief aim, that of teaching one to do something, has been met. I think, too, that a scientific education to the useful may be, and is in most cases, as rigid in discipline as a classical course, and perhaps even more efficient as a means of training to think. Mathematics is always included, and proper teaching of the sciences must of necessity train the reasoning faculty, as well as heighten the powers of observation. The graduate of a technical school is usually able to adapt himself at once to the stern realities of active life, while the classical graduate, outside the learned professions, may be as ignorant as a child upon much that makes up modern life and activities. The demand for scientific education is such that now no institution of any rank altogether neglects it, and many of the universities have schools of technology. Undoubtedly a great mission of science is to serve mankind, by making the material comforts of life more abundant.

I should, however, be doing science a grave injustice were I to leave you with the impression that she is merely the handmaid of the physical pleasures. The study of science for its own sake yields a pleasure of a loftier type. The joy of discovery, the satisfaction that accompanies mere knowledge, is one of the rewards of education. How often do we hear the carping comment, "What is it good for?" or, "What's the use of studying that?" or, "That's all theory; I want something practical." Now, these sentiments represent one aspect of the case, and an important one, but I wish to insist that it is not, and ought not to be, the only attitude. I have no sympathy for the man who has no use for knowledge that cannot be turned into dollars the next day. The satisfaction in life that accompanies an understanding [illegible] processes going on about us should be very great. Probably

there are differences in tastes; occasionally we see some one who seems to have no interest in knowledge of causes; but nearly all children and young people, those who have not been made sordid by the buffetings of hardship, find a real and pure pleasure in knowledge.

I believe that the pursuit of science from the love of truth, with no thought of material reward in cash or honors, is the source of most of the advantages of science that we enjoy. We hear much now of the wonders of electricity, and the place that it has made in our daily life is truly marvelous. I presume that if a hundred educated people, take them as they come, were to be asked who deserves the most credit for this, the majority of them would have to admit that they did not know, and most of the remainder would name Thomas A. Edison. The importance of the work of Edison is not to be questioned, and his name will be written large on the roll of those who have benefited their race by the practical application of science; but back of his work, and far above it in merit, lie the fundamental discoveries of Joseph Henry, a professor of mathematics working at natural philosophy from love of it, and of Michael Faraday, a bookbinder fascinated by science, whose discovery that a magnet moved across a closed conductor generates an electric current therein is the foundation of the modern dynamo. Faraday was a typical man of science, who found his greatest pleasure in studying the workings of nature merely to know them. All honor to him and such as he. While those who have developed and applied fundamental discoveries are not to be despised, as some affect to believe, the greater honor belongs to those devotees of pure science who make the applications possible. I think I am not going too far in saying that the man who is always asking "What good will it do?" or "How much is there in it?" will never accomplish great things even in applying the discoveries of others.

In view of the great accomplishments of science and the stupendous bulk of facts amassed, the question may well be asked: "Is this process of discovery to continue at the same or an accelerated rate in the future, or are the chief generalizations of science now in our possession?" I see no reason why this question might not have been asked at almost any time in the past. It is the tendency of each human society to ascribe to itself accession to the acme of eminence. It is true that facts are not as near the surface now as they were before Faraday, but it is also true that the available weapons of science are correspondingly more potent, and I suspect that a man of genius —a Faraday, a Huxley, or a Darwin—can make discoveries to-day as easily as in 1830. He must acquaint himself with the essential accomplishments of the past, to be sure; and the longer time endures, with its annual additions to these accomplishments, the more preparation

the discoverer of the future will require, but at the same time the greater will be the facilities for imparting that knowledge. The fad for compelling every student of physics or chemistry to discover all of his facts for himself will not endure. He will be permitted to store his mind and memory with the accomplishments of the past, repeating and verifying these to the extent necessary to fix the most fundamental, and to discipline his powers of observation and deduction, and to train him in manipulation. He will then make discoveries of his own, if he has the natural endowment, without which no education and no opportunity is of any avail.

One of the most distinguished physicists of the present day expressed the view that the physics of the future would consist in working on known phenomena and determining constants to the fourth decimal place, or words to that effect. Since then the Roentgen rays have been discovered by a worker in pure science, whose experiments would certainly have been ruled out by the utilitarians, but who has received unstinted praise because of the practical applications that have been made of his discovery. Since then a more remarkable discovery has been made, of which few, comparatively, know as yet. I refer to the radio-activity of matter. I hold in my hand a mineral of very ordinary appearance, which none of you would look at twice unless your attention was especially drawn to it. Yet this humble substance, without any known source of stimulation, is constantly emitting radiations that will penetrate opaque substances and affect a photographic plate, and possess other properties that make them an unsolved riddle to the physicist. Within fifteen years a revolution has taken place in our views concerning the condition of substances in solution. A new view, supported by its power to coordinate diverse known phenomena and to suggest lines of research that in turn add new force to itself, has carried everything before it. It may not, probably will not, remain as it is, but it is a step in the upward progress. Within ten years, so every-day a thing as air has, by the searching methods of modern chemistry and physics, yielded no less than five new elements, that apparently exhibit the hitherto unknown property of possessing no power to enter into chemical combination. No, it will be several years before there are no discoveries remaining to be made in physical science.

I believe, however, that the greatest progress of the future will not be in the fundamental general sciences, chemistry and physics, but in the special sciences all of which rest on them. The study of the phenomena that involve life, both vegetable and animal, is to lead to tangible results. The progress that is being made now in physiological chemistry, especially as related to disease and immunity, is sur-

prising to one who has not been in position to note its progress from week to week, and there can be no doubt that we are on the verge of great advances in that field. We may easily believe that medicine will become a science, instead of a series of experiments with drugs of which we know little upon organisms of which we know less. There are those who even dare to hope that death itself will be conquered by the fuller knowledge of cell processes that the future will reveal. Agriculture, with its twin lines of effort, plant production and animal production, involving, as they do, a more complicated play of natural forces than is displayed in any other industry, will become less uncertain as controllable factors become better understood. Domestic economy may become a science.

I believe that the greatest field for the progress of the future is that which includes consciousness and mentality as factors in the phenomena. I yield to none in admiration for the courage and the genius of the scientists of the past, but it seems to me that there has been by most scientists a tendency to ignore certain classes of phenomena, or to regard them as fraudulent and not even worthy of exposure. While scientists have assailed the conservatism of the theology of the past, they are not themselves free from the conservative spirit that permeates humanity, and, indeed, is in many ways the safeguard of humanity. The tendency of the study of science is toward materialism, and is it not true that this tendency has attained too great force in the past, and led many of us to neglect or discredit phenomena that appeared to be outside the realm of chemistry and physics? If I mistake not, it is within the memory of most of us that the attitude of science towards mesmerism, as it was then called, was one of incredulity and of pity for the deluded victims, mingled with a pharisaical self-satisfaction in the fact that we were not like them. But we have lived to see what was discredited as mesmerism become respectable as hypnotism, and a real remedial agent, the power of which may extend even to the production of complete anesthesia. We have lived to see a powerful organization built up, which has been characterized as neither Christian nor scientific, while claiming to be both, the binding force of which lies in the subtle but intimate connection between body and mind. Some of us will live to see great advances in the study of the mind as related to the body. Even crude observation shows that there is some connection between mental states and physiological processes, and a bold and open acceptance of this as a field for legitimate investigation will probably yield rich returns. I may add that I do not believe that these returns will be obtained either by those who deny the existence of matter or those who believe in nothing else.

The phenomena of spiritualism, so-called, present a field that should yield valuable results of some kind and ought to be a legitimate subject for investigation. Yet Alfred Russell Wallace, who was everywhere recognized as a great scientist, almost lost his reputation by his study of the subject and subsequent adhesion to the faith of spiritualists. Sir William Crookes, great both as a physicist and chemist, investigated the phenomena, and has suffered more or less for it ever since. Is that right? Is it scientific? Do not make the mistake of supposing that I am advocating the claims of Christian science or spiritualism. Far from it. I believe, however, that where a wide-spread belief prevails, there is something to be learned by scientific study; there is a grain of truth, at least, if we will only thrash it out, and my contention is that it is the duty of scientists to hold toward these obscure phenomena the attitude of science instead of prejudice, and, while demanding as incontestable evidence here as elsewhere, to encourage rather than taboo investigation in these lines. The old question, "If a man die shall he live again?" is one which, bidden or unbidden, rises in every breast. Its answer we know no better than did Omar Khayyam, who wrote:

"Myself, when young, did eagerly frequent
Doctor and saint, and heard great argument
About it and about: but evermore
Came out by the same door where in I went.

"Into this universe, and *why* not knowing
Nor *whence*, like water willy-nilly flowing;
And out of it as wind along the waste,
I know not whither, willy-nilly blowing.

"Up from Earth's center through the seventh gate
I rose and on the throne of Saturn sate,
And many a knot unraveled on the road;
But not the master-knot of human fate.

"There was the door to which I found no key;
There was the veil through which I might not see:
Some little talk awhile of ME and THEE
There was—and then no more of THEE and ME.

"Earth could not answer; nor the Seas that mourn
In flowing purple of their Lord forlorn;
Nor rolling Heaven with all his signs, revealed
And hidden by the sleeve of night and morn."

"To hope is one thing, to believe another; to know is quite another." It is the future task of science to contribute something to the unraveling of the "master-knot of human fate."

The experimental study of the mind and consciousness will occupy the scientists of the future far more than it has those of the past.

The mystery of consciousness, so profound as to seem impenetrable, will certainly yield something to experimental investigation. The subject possesses an interest amounting to fascination, but it is entirely beyond my ability to discuss. The distinguished Professor Minot, in his presidential address before the American Association for the Advancement of Science, last summer, advanced the hypothesis that the universe consists of matter, energy, and consciousness. Is it too much to say that consciousness presents the most profound problem of science? Is it too much to believe that the future holds some Newton who will reveal the solution?

Human nature in its natural condition is positive, prejudiced and narrow. The study of science gives breadth; the attitude of science is one of receptivity. He who has in part gained the clearer vision, who has penetrated some of the mists of verbiage, realizes that all knowledge is relative; that absolute knowledge of even one thing is not within the power of the human intellect; that not only the infinitely little and the infinitely large are beyond our deepest ken, but the every-day phenomena which so many think they know. In ultimate analysis, I think we can be sure of but one thing, "I think, therefore I am." This, only, is positive; all else is relative. When we reach that point we are humbled; we realize our insignificance in the universe, and we drop our attitude of positiveness and prejudice, and, on the broad platform of tolerance for every sincere view, we consider with cold, passionless intellect the various thoughts that come, or are presented, concerning the relations between phenomena. Not all students of science have reached this point; many get into a groove which they wear so deep that they can see out in but one direction; they work to prove a theory rather than to make a better one; but the tendency is stronger in science than anywhere else toward breadth and tolerance. By those who know little of its controversies, science is accused of endeavoring to fasten her theories on mankind regardless of facts. These little suspect the joy that would fill a young scientist could he but assert, and plausibly maintain, some new hypothesis that would displace the old. This is the spring of life in science: the realization that all knowledge is relative, and that what we call truth is but the expression of views that at the time coordinate most phenomena. Next year, next day, may bring a new fact that will necessitate a new theory. This is no disgrace to science; it proves her to be alive and growing; it demonstrates her elasticity and perennial vitality. Let him who boasts of certainty and permanence beware lest he be found hugging a delusion born of prejudice and ignorance.

During the last half of the last century we heard much of the con-

flict between religion and science. There were those who maintained that no such conflict existed, and others who believed that there was war to the death. The present generation cannot appreciate the state of affairs that existed, so violent was the opposition to the then new teachings of science. To believe in the doctrine of evolution was to brand yourself as an infidel without further ceremony. To believe that the earth required more than the time represented by six of our ordinary days for its formation was scarcely less reprehensible. The doctrines of the conservation of energy and of mass were also dangerous, though perhaps less so because their tendencies were less apparent. I remember the horror which an old gentleman expressed for that uplifting and inspiring passage in one of Tyndall's brilliant lectures in which he traces nearly everything earthly to the sun. In his view, Tyndall left no place for God. For years Henry Ward Beecher was the only preacher of note that had the breadth and courage to avow his acceptance of the tendencies and teachings of evolution. There were doughty fighters on both sides. There were prejudice and intolerance on both sides. There was lack of sympathy with sincere convictions on both sides. I do not care to make quantitative comparisons at this time. As always, the younger generation is bearing the banner of progress, and in some form the views of science in respect to the age of the earth, the origin of species and the relations of matter and force are accepted with as little concern by this generation as the ideas of the rotundity of the earth and its diurnal revolution were accepted by the previous one. It is important to recognize, too, that, with this prevalence of the views of scientists, "pure religion, and undefiled" has suffered not the slightest loss. In fact, by the trend of events, the methods of science have been introduced into the study of religions, with the result that it has taken on new life, and there is every reason to believe that the future will show developments that will ultimately lead to the reunion of all who sympathize with all that tends to the moral elevation of mankind.

The nineteenth century will probably always rank as the century of science. Great as have been the material advantages resulting from the discoveries of that century, I believe that its greatest, its farthest-reaching triumph was the emancipation of the intellect. Science, by her unfaltering courage and superb accomplishment, has become the dominant power of society. The progress of scientific thought is but one phase of the general progress of liberty. The mission of science is but begun; her methods are being applied in all fields of mental activity, and progress in the study of economics, sociology, ethics and theology will be made by the application of the same principles that have advanced astronomy, physics, and chemistry, viz., an

unprejudiced mind, accurate observation, well-chosen experiment, and logical reasoning upon things as we find them, not as we imagine them or think they ought to be. When all approach these subjects in this way, we need have no fear concerning the effects of the progress. Thinkers of every type recognize that truth is a unit, of which each may dig out a bit, but none can have all, and that no fact can possibly be at variance with truth as a whole. Gerald Stanley Lee put volumes of sound theology in six words when he said "When a fact speaks, God speaks." The highest mission of science is so to amass facts, and to train minds by their study, that the so-called supernatural shall be brought within the realms of things known with the same degree of certainty that the things of chemistry and physics are known. Absolute knowledge beyond consciousness of our own existence and sensations we cannot attain. Speed the day when he who gathers truth from whatever field will be welcomed with his sheaves, no matter how unfamiliar the grain!

II.

CHEMICAL AND PHYSICAL PAPERS.

"A Study of Dietaries at Lawrence, Kan."
By E. H. S. Bailey, of the University of Kansas, Lawrence.

"Crystalline Liquids."
By Fred B. Porter, of the University of Kansas, Lawrence.

"Some Kansas Petroleum."
By Edward Bartow and Elmer V. McCollum, of the University of Kansas, Lawrence.

"The Composition and Digestibility of Prairie Hay and of Buffalo-grass Hay."
By J. T. Willard and R. W. Clothier, of the Kansas Agricultural College, Manhattan.

"Distinguishing Red and White Oak Lumber by Chemical Analysis of their Ash."
By E. B. Kneer, of Midland College, Atchison.

"On the Alkyl Sulphates."
By F. W. Bushong, of Kansas City College, Kansas City, Kan.

"Some Sandstone Waters of Great Purity."
By E. H. S. Bailey, of the University of Kansas, Lawrence.

A STUDY OF DIETARIES AT LAWRENCE, KANSAS.

By E. H. S. Bailey, University of Kansas.

Read before the Academy, at Topeka, January 1, 1903.

SCIENTIFIC investigation of the present day is pointing more strongly to the fact that without attention to the quality and quantity of the food consumed man can never be at his best morally, intellectually, or physically. Food is taken into the body to nourish it and enable it to perform properly its functions, but the appetite incites us to take food frequently which, both in kind and amount, is injurious.

As we are discussing more especially food substances, and their value in sustaining the machine which we call the human body, it is proper to notice the economic conditions that govern our choice. Just as the recent coal strike has led to the discovery and development of new fuels to take the place of anthracite, so the scarcity of food, from its high price or, what amounts to the same thing, a decrease in wages at any time, leads to the substitution of new food supplies and to the more economical use of those which we have.

The food materials contain water, proteids like the albumen of meat and eggs, carbohydrates like those in starch and sugar, fat from both the vegetable and animal kingdoms, and mineral salts. If the animal is allowed to eat the vegetable food, and we eat the flesh of the animal, we get the proteids in a concentrated form. In the vegetable kingdom, the leguminous plants, such as beans and peas, furnish the largest relative quantity of protein.

Looking over the broad field of food supply, we notice: First, foods are cheaper or dearer as they are in or out of season, but the season has been much extended by convenient and cheap transportation, and since canned fruits and vegetables have been introduced many vegetable foods are to be obtained throughout the year at reasonable prices. Second, there is very little relation between the cost of foods and their nutritive value. Beans are more nutritious than plum pudding, but they cost less. Third, a cheap food is not necessarily a poor food, or an expensive food a good food. Fourth, an expensive food can be spoiled for the palate and rendered unwholesome by poor cooking, and a cheap food can be made at least palatable and wholesome by skilful cooking.

Without going into details, it should be noted that foods like the protein compounds are mostly used to form the material of the body

and repair the waste, while foods such as the fats and the carbohydrates are used to keep the body warm and furnish the muscular power to do work.

In order to measure the value of a food, we adopt as a measure the calorie; that is, the amount of heat required to raise one pound of water from 0° to 1° centigrade. By this standard, one pound of protein will furnish 1860 calories; one pound of fat, 4220 calories; and one pound of carbohydrates, 1860 calories. In the adjustment of the proportion of these ingredients of the food, it is essential that we provide enough protein to build up and repair the tissues of the body, and enough fats and carbohydrates to keep the body warm and enable it to do its work.

Professor Voit, of Munich, one of the best authorities on this subject, has placed the standard for ordinary hard, muscular work as .25 pound protein, and carbohydrates and fats enough to yield, with the protein, 3050 calories of energy per day.

Professor Atwater suggests .28 pound of protein per day and a total of 3500 calories of energy for a man engaged in strong muscular labor. Professional men and students in Europe do well on .23 pound of protein and enough carbohydrates and fats to make up 2700 calories, but experience shows that in the United States the amounts actually used for this class are larger; in fact, about 3000 calories seem to be required.

In making calculation of the nutritive values of the food, the quantity of fat is multiplied by 2¼, as its fuel value is this much higher than the carbohydrates. To this product we add the carbohydrates and divide the sum by the protein. The nutritive ratio should be from 1:4.7 to 1:6.9. The examination of a large number of dietaries in use in this country shows that there is a tendency to use too much starch, sugar and fat in proportion to the protein. In Europe the quantity of fat is from 1 to 5 ounces per day; in the United States it is from 4 to 16 ounces per day. Well-to-do professional men in Germany use from 3 to 4⅔ ounces of fat per day, while in the United States the same class of people use from 5 to 7½ ounces per day. The carbohydrates amount to from 9 to 24 ounces as used in Europe, but the same class in the United States use from 24 to 60 ounces. The proportion of protein to carbohydrates in Europe is as 1 to 4.1 to 6, while in this country it is as 1 to 6.6–8.2.

Something over two years ago, I requested one of my students, who was a steward of a student club of forty-six members, to make a dietary study of the food consumed during one month. In making this study, he followed the plan outlined by Professor Atwater in Bulletin No. 28 of the United States Department of Agriculture. The

average fuel value was found to be 3923 calories, with a nutritive ratio of proteids and carbohydrates of about 1 to 8. This showed the fuel value to be high; that is, there was too much starch and sugar consumed for the class of work done. Three thousand calories, as has been previously stated, is considered sufficient for those who are not engaged in very active muscular work.

It is a significant fact that in the Southern states there is a still greater tendency to use too much fat, starch, and sugar, and too little lean meat. According to the statement of the club steward in the above, Kansas seems to have the Southern tendency. Less pork and corn-meal (substances rich in fats) should be used, and more lean beef, oatmeal, peas and beans—substances rich in proteids.

The cost of the food in this club was 19½ cents per day per capita, or $1.36 per week. There were twice as many females in this club as males, but it was the observation of the steward that the amount of food eaten was not diminished by this fact, although authorities reckon that a woman eats four-fifths as much as a man.

Much valuable food is thrown away, even when it is purchased at a high price. When we eat more than is good for us, we throw away food. Cases are mentioned in ordinary domestic life in which 7.6 per cent. of the food was thrown away with the kitchen waste, and as this waste was taken largely from the protein and fat, it was estimated that .1 of the protein and fat and .04 of the carbohydrates purchased were wasted. The fact is, then, we waste a greater proportion of the protein, which is the most expensive and the most needed form of nutriment.

More recently, through the courtesy of a steward of one of the clubs in the University, I have been able to make another comparison of food, with estimate of cost. In this club there were twenty-two persons, and the records are given for sixty-five days. The following is the reported value of the different kinds of food:

Articles.	Protein.	Fat.	Carbohydrates.	Calories (fuel value).
Animal Foods:				
Beef, roast	45.31	36.03	.....	250.875
Beefsteak	10.56	5.06	.....	47.025
Veal	3.32	1.58	.....	13.800
Pork, fresh	6.80	14.00	.....	71.750
Pork, salt	.62	28.44	.....	121.110
Chicken	17.55	1.40	.....	38.610
Gelatine	5.35	.....	.....	9.960
Eggs	9.24	6.93	.....	47.586
Oysters	.35	.09	.....	1.340
Lard	.....	125.00	.....	422.000
Lard, leaf	.22	9.40	.....	40.100
Salmon	4.68	1.80	.....	16.320
Fish	1.74	2.49	.....	13.725
Milk	33.00	40.00	.....	325.000
Cheese	1.69	2.13	.....	12.420
Butter	1.07	80.95	.....	386.805

Articles.	Protein.	Fat.	Carbo-hydrates.	Calories (fuel value).
Vegetable Foods:				
Wheat flour	22.00	2.20	159.80	329.000
Graham flour	2.92	.49	17.91	40.625
Oatmeal	2.11	.99	9.55	26.200
Malta Vita, Grape-nuts	8.40	3.92	35.19	103.600
Rice	.29	.02	3.17	6.520
Tapioca	.....	.....	2.59	4.950
Starch	.....	.....	4.50	8.375
Corn, canned	1.34	.65	9.12	21.840
Corn, roasting	.40	.22	3.04	7.270
Potatoes, Irish	40.32	1.90	343.68	720.000
Potatoes, sweet	5.76	1.53	99.84	203.520
Turnips	1.00	.....	6.32	13.875
Pumpkin	.....	.....	.31	1.720
Tomatoes	.28	.05	.96	2.520
Peas	.86	.05	2.37	6.120
Cabbage	1.57	.22	4.12	11.625
Beans	5.40	.43	14.34	38.520
Crackers	4.50	4.18	33.58	87.550
Cakes, cookies	2.12	2.52	20.72	53.200
Sugar, granulated	.....	.....	253.00	470.580
Syrup	.....	.....	28.56	53.200
Honey	.....	.....	3.24	6.080
Bread	37.20	4.80	210.80	482.000
Bread, brown	1.95	.39	11.46	26.620
Cranberries	.....	.10	1.78	3.870
Grapes	.56	.67	8.06	19.760
Bananas	.48	.24	8.58	18.000
Oranges	.07	.....	1.02	2.040
Pecans	.17	.14	4.44	9.100
Apricots, canned	.41	.....	10.56	72.000
Plums	.45	.....	9.50	8.500
Plums, canned	.22	.....	3.88	7.920
Lemons	.....	.....	.47	1.160
Chocolate	.38	1.46	.90	8.580
Baking-powders	.16	.....	1.12	2.467
Celery	.22	.....	.65	1.750
Apples	1.08	1.08	38.88	79.200
Peaches	.50	.....	6.70	12.750
Peaches, canned	.25	.....	3.88	7.920
Melons	.50	.25	6.75	15.000
Totals	285.37	393.73	1,287.95	4,762.978

The cost of the food in this case was reported at 17⅛ cents per day per capita. At another date, when the tests were made for a shorter period, though under conditions that assured greater accuracy, the cost was 18⅛ cents per day per capita.

The estimates were made on food as purchased, making the usual allowances for refuse, such as bone, skin, shell, etc., of the food, as these are bought and paid for at the rate of so much per pound or bushel or quart. These are no small items either, for some cuts of beef lose 20 per cent. from refuse and bone that cannot be used. Chickens, alive, lose 38 per cent. Fish lose from 40 to 50 per cent. in this way.

The amount of water, also, is more than we should at first suppose, both in meats and in vegetables. Sirloin steak contains 38 per cent., blue fish 43 per cent., potatoes 78 per cent., turnips 89 per cent. and bread 32 per cent. of water.

The most expensive items of this dietary are beef, which in the above estimate costs $39.78, out of a total of $242; and all the animal food, including meats, eggs, milk, cheese, and butter, costs $142.

59 per cent. Of the carbonaceous foods, the largest items were sugar, syrup, and honey, all together, $13.30; and bread, white and brown, $11.65. The calories per day per capita were 3437. The nutritive ratio, as shown by the amounts of proteins and fats together, and carbohydrates, estimated as previously noted, is 1 : 7.6.

Here again it will be seen that the total number of calories in the food is not so much out of the way, though a little high, but the same condition prevails as in the other case; that is, the nutritive ratio is wide—too much fat and carbohydrates in proportion to the proteids.

The table following gives some of the results observed both in this country and abroad in respect to *fuel value* of foods and *nutritive ratio*. These are selected from many hundred that have been published, so as to show an average and some special facts. Here also is seen the tendency of our Southern people to eat too much fat and starch. The figures in parentheses give the number of families or clubs studied.

COMPARISON OF DIETARIES.

	Fuel value (calories).	Nutritive ratio. 1:-
Negro farmers, Tennessee	3,270	11.8
Cotton operators, Lowell, Mass	4,650	7.6
Mechanics, etc., New England (20)	5,275	7.3
Average for professional men (9)	3,315	6.8
Saxony, working people (13)	2,275	7.0
Middle class, European (11)	3,150	5.3
Laborers, Bavaria (5)	3,295	4.9
Javanese (World's Fair)	1,490	4.5
Football team	6,070	6.6
Average wage-earner, Connecticut	3,605	6.7
United States army ration	3,850	6.8
Students' club, Connecticut	3,140	6.7
" " Missouri	3,560	8.0
" " Tennessee	3,520	8.3
" " average (15)	3,700	7.4
" " Kansas	3.437	7.6

CRYSTALLINE LIQUIDS.*

By FRED B. PORTER, University of Kansas.

Read before the Academy, at Topeka, January 2, 1903.

CRYSTALLINE LIQUID is a term that has come into use to describe a phase in which a few substances have properties of both liquids and crystals. At certain temperatures these substances appear to the naked eye like ordinary liquids. They are free flowing, but have a cloudy or milky appearance. Under the polarizing microscope, however, they show double refraction, a property of crystals. At a higher temperature they suddenly lose the cloudiness and the double refractive powers and attain the true liquid phase. The temperature at which the solid changes to the cloudy liquid is the melting point, and the temperature at which the cloudiness disappears is called the transition point.

The first substance which was observed to have these peculiar properties was Cholesterine benzoate ($C_{36}H_{43}OOCC_6H_5$), (Schenck, Zeits. Phys. Chem. 25, 337). In 1887 Reinitzer, a German chemist, observed that this substance melted at 145° to a cloudy liquid, and that at 178° the cloudy appearance suddenly disappeared. He did not, however, observe its double refraction.

In 1890 three azoxyphenolethers, which had this cloudy modification of the liquid state, were made and studied by Gatterman (Be. 23, 1738). The composition, melting points and transition points of these substances are shown in the following table:

Name.	Formula.	Melting point.	Transition point.
Paraazoxyanisol,	$CH_3OC_6H_4\text{-}N(O)\text{-}N\text{-}C_6H_4OCH_3$	114°	134.1°
Paraazoxyphenetol,	$C_2H_5OC_6H_4\text{-}N(O)\text{-}N\text{-}C_6H_4OC_2H_5$	134.5°	164.2°
Anisolazoxyphenetol,	$CH_3OC_6H_4\text{-}N(O)\text{-}N\text{-}C_6H_4OC_2H_5$	86°	116°

Gatterman also found that these substances, when exhibiting this cloudy appearance, have the property of double refraction. This he observed by means of a special apparatus for heating the substance under the polarizing microscope. Such an arrangement is necessary to observe the double refraction in the crystalline liquids thus far known, because none have been discovered that have the crystalline liquid phase at ordinary temperature.

The properties of the azoxyphenolethers have been further studied

*Abstract of a thesis presented to the faculty of the School of Engineering of the University of Kansas for the degree of bachelor of science in chemical engineering. The work was carried on in the laboratory of organic chemistry, under direction of Prof. Edward Bartow.

by Lehman (Zeits. Phys. Chem. 5, 427). He suspended drops of these substances in a medium of the same density, and found that the drops had two axes, as in solid crystals. The drops were rounded in form, but when two of these came in contact, instead of forming one drop with only two axes, four axes still remained. Pressing drops between glass plates did not destroy the axes, as might be expected.

The study of other physical chemical properties of these crystalline liquids has been carried on by Schenck. (Zeits. Phys. Chem. 25, 337). He determined their density at different temperatures, and found on platting the density curves that he obtained nearly straight lines, with the exception that at the transition point the density changes suddenly while the temperature remains constant, making a jog in the curve. The curves for all the crystalline liquids known are similar.

The molecular weight of the substances in the two liquid phases was found to be the same; that is, there is no change in the size of the molecules when the liquid passes through the transition point. We must have, then, two liquids which are chemically identical, but different in their physical properties, and, therefore, truly physical isomers. A curve showing the relation of the different phases of one of these substances could be drawn similar to the curve for sulphur. Sulphur has one vapor, one liquid and two solid phases, the monoclinic phase occupying a triangle (see Physical Chemistry, Walker), while a crystalline liquid has one vapor, two liquid, and one solid phase, the crystalline liquid phase occupying a triangle.

Such peculiar properties seemed worth observing, so we decided to make one of these substances. With the materials at hand, the preparation of *p*-azoxyanisol promised the best results. The compound from which *p*-nitrophenetol was made by Gatterman is now on the market, but as it could not be procured at once, it became necessary to make it. The *p*-nitrophenetol can be made (1) by treating *p*-phenetol with fuming nitric acid (Hallock, Am. 1, 271), or (2) by boiling *p*-nitrochlorbenzene with alcoholic potassium hydroxide solution (C. Willgerodt, Be. 15, 1002). The latter method was used. The *p*-nitrochlorbenzene was prepared from chlorbenzene, and the chlorbenzene from benzene itself.

For the preparation of chlorbenzene, benzene was chlorinated in the presence of aluminum turnings. The resultant liquid colored by decomposition products, contained varying amounts of the chlorbenzenes, which were separated by fractional distillation. The relative amounts of the mono-chlorbenzenes depended upon the amount of chlorine led into the benzene, and on the temperature during chlorination. The best results were obtained by warming the benzene until

it was evident that the reaction was beginning and then cooling it as soon as possible. In this way almost no black decomposition products and relatively more of the mono-chlorbenzene was obtained. In the fractional distillation, a part distils over below 90°. This was used in the next chlorination. The next fraction contains mono-chlorbenzene, b. p. 132°. At higher temperature, small amounts of dichlorbenzene, b. p. 172°, and of 1, 2, 3, 4-tetrachlorbenzene were obtained; and finally in one case, when the chlorination was carried too far, some higher distillations were obtained, even up to 300°; but no other pure compounds were separated. It was necessary to repeat the fractional distillation at least seven times to separate the compounds.

Para-nitrochlorbenzene was next prepared (Riche A. 121, 357), by nitrating the chlorbenzene with fuming nitric acid at the temperature of ice-water. Both the ortho and para compounds are formed. At first the para compound was obtained pure by repeated crystallizations, but it was found later that an almost complete separation could be made by means of a Buchner funnel and the suction-pump. The ortho compound contains a considerable quantity of impurity, and is a liquid, and if pure it should melt at 32.5°. The para compound being solid, m. p. 83°, remains on the filter.

Paranitro-phenetol was then obtained (C. Willgerodt, Be. 15, 1002) by heating a mixture of 300 cc. alcohol, 150 cc. water, 10.5 g. potassium hydroxid, and 30 g. *p*-nitrochlorbenzene for thirty-six hours in a flask with a return condenser. The product obtained, after diluting with water and filtering, was purified by distillation with steam. The unchanged *p*-nitrochlorbenzene distils over first, followed by the *p*-nitrophenetol. A solid dichlorazoxybenzene, melting at 155°, and *p*-nitrophenol in solution remain in the flask.

Paraazoxyanisol was next prepared. Six g. sodium, 60 g. methyl alcohol, and 16 g. *p*-nitrophenetol (Schenck, Zeits. Phys. Chem. 25, 346), were sealed in tubes and heated for five hours at 110°, in the bomb furnace. The product, treated with alcohol, left a solid, which, when crystallized from chloroform, melted at 114°, and passed its transition point at 134°. As no microscope with heating stage was available, the double refraction of the paraazoxyanisol could not be observed by us.

SOME KANSAS PETROLEUM.

By EDWARD BARTOW and ELMER V. MCCOLLUM, University of Kansas.

Read before the Academy, at Topeka, January 1, 1903.

OUR attention was called to the fact that there must be considerable variation in Kansas petroleum when some specimens differing entirely in character were sent to the laboratory of organic chemistry for analysis. We therefore thought it advisable to collect specimens from various parts of the Kansas oil fields, and to make tests to prove our conclusion that there was a decided variation in the character of the oils from different parts of the field. This paper tells of our observations of the specific gravity, flash point and burning point of eight samples of oil collected in Allen and Neosho counties.

To prevent loss of volatile oils, it is desirable that the samples be collected directly from the wells. Owing to the different stages in the development of the pumping arrangements of these wells, it was not always possible to collect the samples under like conditions. We have noted the conditions of collection below.

We have not included the record of the depth of the wells in this paper, because the height above sea-level and the dip of the strata must also be taken into consideration in order to make an accurate comparison of the depths.

Sample No. 1 was from a well about three miles north of Chanute.

Sample No. 2 was from a well about one and one-half miles east of Chanute.

Sample No. 3 was from a well three miles south of Humboldt. This sample was taken directly from the well by the writer.

Sample No. 4 was from a well two miles north of La Harpe, and had been in barrels exposed to the air for several days before collection was made. The well was new, and had been shot only about ten days.

Sample No. 5 was from a well in the northern part of the city of Humboldt, and was taken from a tank into which it had been pumped. The Engler test showed water.

Sample No. 6 was from a well four miles southwest of Humboldt, and was in part taken directly from the flowing well and part from a barrel.

Sample No. 7 was from a well about a mile west of Humboldt, and was pumped directly from the well.

Sample No. 8 was from the schoolhouse well in Humboldt. The [illegible] is primarily a gas well, but some oil collects and must be pumped

at intervals. The oil obtained had been pumped three or four hours before it was secured by the writer.

The following table shows the relative properties of eight samples of oil from Allen and Neosho counties:

No.	Specific gravity.	Baume.	Flash point.		Burning point.	
			Fahrenheit.	Centigrade.	Fahrenheit.	Centigrade.
1.....	0.866	32.5	52°	11°	77°	25°
2.....	0.872	31.3	112	39	129	54
3.....	0.940	19.3	289	143	360	172
4.....	0.906	25.	167	75	208	98
5.....	0.912	24.	160	71	241	116
6.....	0.880	30.	52	11	124	51
7.....	0.874	31.	52	11	79	26
8.....	0.875	31.	77	25	124	51

In the above table, we would call attention to the following differences: The specific gravity varies from 0.866 (Baumé 32.5), in No. 1, to 0.940 (Baumé 19.3), in No. 3. No. 3 and No. 5 contain some water, which makes the specific gravity a trifle higher than the dry oil would be.

The flash points vary from 11° C. (52° F.), in Nos. 1, 6, and 7, to 143° C. (289° F.) in No. 3.

The burning points vary from 25° C. (77° F.), in No. 1, to 72° C. (360° F.), in No. 3.

We have also made distillations of the above samples according to the method of Engler. We used 300 cc. of crude oil, and carried on the distillation in 500 cc. glass distilling flasks. We collected the distillates in five-per-cent. fractions. The results of these determinations we will report in a later paper.

Judging from this preliminary work, the results seem to warrant the continuation of the examination of oils from other parts of the Kansas field.

THE COMPOSITION AND DIGESTIBILITY OF PRAIRIE HAY AND OF BUFFALO-GRASS HAY.

By J. T. WILLARD and R. W. CLOTHIER, Kansas State Agricultural College.

Read before the Academy, at Iola, December 31, 1901.

A NUMBER of digestion experiments have been carried out in recent years at the Kansas State Agricultural College Experiment Station, and it seemed that two of these might be of some interest to the Academy, namely, those on prairie hay and buffalo-grass hay. It is well-known that our prairie hay of the eastern part of the state is not in high repute as a feed, and it is even more uniformly true that the short grass of the plains has always been in favor. Even when dead it has served to nourish animals well and bring them through the winter without other feed, when snow did not prevent access to it. Undoubtedly there are great differences among various samples of both the grasses in question and hays made from them, and the results here recorded are not submitted as definitive, but they certainly are suggestive.

The prairie hay used was from the uplands of Riley county, and was regarded as of good quality. No botanical analysis was made of it, but it probably contained a good deal of the little bluestem. It was cut about August 1, 1898, and was prepared for sampling and feeding by running it through an ensilage cutter. After a preliminary feeding of six days to clear the digestive tract of other feed, the test proper began and continued for six days more. Twenty pounds per day were fed, of which about three-fourths were eaten. The animal used was a three-year-old Hereford steer.

The buffalo-grass hay was cut with a lawn-mower in Logan county, during the latter part of July, 1899. It required about ten days' work to get 300 pounds of hay. This was shipped to the station in excellent condition. This hay required no further cutting to prepare it for uniform mixing and sampling. It was fed to a yearling steer, a grade Short-horn. Not being accustomed to this delicacy, our steer refused to eat it at first, and had to be brought to the ration by mixing it with alfalfa and gradually increasing the proportion of the buffalo-grass. In about six days he was on the pure buffalo-grass. He was given a preliminary feeding of five days, followed by five days of the period of exact observation. He was given eighteen pounds per day, and ate about three-fourths of it.

The table following gives the more interesting details of the results. It will be seen that, in respect to the total dry matter, the two hays

are almost identical, but that we have an enormous difference in the amount of protein present and in the digestion coefficient of the protein. Buffalo-grass, in fact, is found to be very much superior to any of the ordinary rough feeds and fodders. It is fully equal to Kentucky blue-grass and but little inferior to red clover.

It should perhaps be stated that the digestion experiments and the analyses were performed in the usual manner, and that in the table, for convenience, certain data are expressed in more than one way. Thus, the pure proteids are a part of the crude protein and the carbohydrates are the sum of the fiber and the nitrogen-free extract.

Composition, coefficients of digestibility and percentages of digestible constituents in prairie hay and buffalo-grass hay.

	Water.	Ash.	Crude protein.	Pure proteids.	Fiber.	Nitrogen-free extract.	Carbohydrates.	Fat.	Total dry matter.
Composition of the air-dry substances.									
Prairie hay	9.07	7.86	3.62	3.62	29.77	47.44	77.21	2.24	90.93
Buffalo-grass hay	8.16	12.10	11.31	10.00	24.10	42.33	66.43	2.00	91.84
Coefficients of digestibility, *i. e.*, the percentage of each constituent that is digestible.									
Prairie hay		25.30	17.67	20.91	61.18	61.25	61.07	56.57	51.45
Buffalo-grass hay		6.04	54.38	57.70	64.65	61.71	62.75	62.41	50.08
Percentages of digestible constituents in the air-dry substances.									
Prairie hay		1.97	0.61	0.74	17.76	29.14	46.90	1.97	51.45
Buffalo-grass hay		0.70	6.20	5.88	15.77	26.24	42.01	1.28	50.08

DISTINGUISHING RED AND WHITE OAK LUMBER BY CHEMICAL ANALYSIS OF THEIR ASH.

By E. B. KNERR, Midland College, Atchison.

Read before the Academy, at Topeka, January 1, 1903.

A FEW years ago the county surveyor of Atchison county appealed to the author of the following notes for information as to methods of distinguishing between red and white oak lumber. It seems that among his duties was the inspection of the lumber purchased by the county for bridge purposes, and, as the contracts called for white oak, he wanted to be sure that white oak lumber was being furnished, and not red oak, which usually rates in the market at two dollars less per thousand feet than white oak.

As is well known, the color of a freshly planed surface affords no reliable information as to the nature of the material, the white oak frequently being darker than the red. True, white oak is usually more closely grained than the red, but even this distinction may be deceptive in material from widely separated localities. Again, the white oak is usually heavier than the red, weighing forty-six pounds to the cubic foot, while the red weighs but forty-one pounds on the average. But, as may be readily seen, results as to weight will be greatly modified by the amount of seasoning, time of cutting, method of storing, etc.

It occurred to the writer that possibly a chemical analysis of the ashes of the several varieties might be of service in determining the kinds of lumber in question. Accordingly, a sample each of white, red, post and willow oaks was obtained from the Carlisle Lumber Company, of Atchison. The material was furnished direct from their mills in Arkansas, and represents results from one locality alone. The red and willow oaks are of the black oak tribe, the members of which require two years to perfect their fruit, while the white and post oaks belong to the annual-fruited division. The representatives of the black oaks gave a much higher percentage of ash than those of the white oaks, ranging over thirty-two-hundredths per cent. of the seasoned wood for the former, and less than twenty-hundredths per cent. for the latter. This difference was found mainly in the quantity of lime and potash present, the red oaks showing about twenty per cent. more of lime and five per cent. more of potash in the ashes than did the white oaks.

Bearing these considerations in mind, we should have here a sure method for distinguishing disputed samples of white and red oak.

ON THE ALKYL SULPHATES.

By F. W. Bushong, Kansas City University.

Read before the Academy, at Topeka, January 1, 1903.

TWO lowest members of the series of neutral alkyl sulphates, dimethyl sulphate and diethyl sulphate, have long been known. In 1870 Chapman[1] obtained impure diisoamyl sulphate by passing sulpur dioxide into isoamyl nitrite. Stempnewsky[2] states that alkyl sulphates are formed by the interaction of silver sulphate with alkyl haloids, but Nef[3] found that while this method yields normal dipropyl sulphate and diisoamyl sulphate it does not furnish diisopropyl sulphate nor diisobutyl sulphate, and accounts for this by pointing out that these esters possess very low dissociation points. On this account, he suggests that the only possible method which presents itself for their synthesis at low temperature is the interaction of sulphuryl chloride or its esters with alcoholates.

Following this suggestion, I have prepared ethyl isopropyl sulphate, ethyl isobutyl sulphate and ethel isoamyl sulphate from chlorsulphonic ethyl ester and sodium alcoholates, and diisopropyl, diisobutyl and diisoamyl sulphates from sulphuryl chloride and the sodium alcoholates.

The reaction between sulphuryl chloride and sodium alcoholates is complicated and the yield of alkyl sulphate cut down by the dissociation of the sulphuryl chloride into sulphur dioxide and chlorine. I wish, on this account, to investigate this reaction further before stating my results, and at present describe only my experiments with chlorsulphonic ethyl ester.

CHLORSULPHONIC ETHYL ESTER, ITS PREPARATION AND PROPERTIES.

Soon after the constitution of sulphuric acid and its relation to chlorsulphonic acid and to sulphuryl chloride had been established, R. Williamson[4] prepared chlorsulphonic ethyl ester "by direct combination of chloride of ethyl with anhydrous sulphuric acid. Its composition was determined by finding the weight of the product obtained by combining a known weight of SO_3 with chloride of ethyl."

Purgold[5] found that in this reaction at least two of the three possible isomers are formed, and his work has, in part, been confirmed by Armstrong.[6] He also proved that the ester thus obtained is identical with the chloranhydride of ethyl sulphuric acid, which he made by

1. Ber. d. chem. Ges. 3, 920 (1870).
2. Ber. d. chem. Ges. 11, 514 (1878).
3. Liebig's Annalen 318, 40 (1901).
4. Jr. Chem. Soc. 10, 100 (1857).
5. Leibig's Annalen 149, 124 (1869), Ber. d. chem. Ges. 6, 502 (1873).

the action of phosphorus pentachloride upon dry potassium ethyl sulphate, as well as with a body prepared by Wilm[6] by the action of fuming sulphuric acid upon chlorcarbonic ethyl ester, carbon dioxide being liberated.

M. Müller[7] obtained the same compound, together with isethionic acid, by passing ethylene into chlorsulphonic acid.

It was also obtained by Sandmeyer[8] by the addition of ethyl hypochlorite to sulphur dioxide.

On passing chlorine gas, free from air, into a solution of sodium bisulphite in ten per cent. aqueous alcohol, I have found that chlorsulphonic ethyl ester is at first formed rapidly, but is destroyed as soon as a considerable quantity of hydrochloric acid has been formed.

Through Claesson's method[9] free ethyl sulphuric acid is now easily accessible, and from this Nef[10] has prepared chlorsulphonic ester by means of phosphorus pentachloride, but I have had difficulty in removing the last traces of phosphorus from the ester thus made.

The chlorsulphonic ethyl ester used in the experiments hereafter described was made from sulphuryl chloride and alcohol by the following modification of Behrend's method:[11]

Sulphuryl chloride (Kahlbaum's) was put into a distilling flask fitted with a doubly perforated stopper, through which were inserted the stem of a dropping funnel and a glass tube connected with a calcium chloride drying tube. The end of the glass tube was drawn out until almost capillary, and dipped below the surface of the sulphuryl chloride. The delivery stem of the distilling flask led to a wash-bottle containing water and provided with a safety tube. The wash-bottle was connected with an aspirator, and air was drawn through the liquid for the double purpose of keeping the liquid constantly stirred and of carrying away the extremely irritating fumes. The flask was immersed in a freezing mixture. Absolute alcohol (a little in excess of one molecule) was admitted drop by drop from the dropping funnel. When all the alcohol was admitted the freezing mixture was removed, but the air current was maintained about half an hour longer, until the liquid acquired the temperature of the room and became perfectly colorless. After standing, two layers may be distinguished; the lighter and smaller consists mainly of ethyl sulphuric acid, and the heavier of nearly pure chlorsulphonic ester. The lower layer, after washing with cold water, drying with calcium chloride, and distilling under reduced pressure, yields over sixty per cent. of the theoretical quantity of the pure ester.

I. 0.3372 gram substance gave 0.5528 gram $BaSO_4$.

6. Jr. prak. Chem. (2) 1, 244 (1870).
7. Ber. d. chem. Ges. 6, 227 (1873).
8. Ber. d. chem. Ges. 19, 860 (1886).
9. Jr. prak. Chem. (2) 19, 231 (1879).
10. Liebig's Annalen 318, 40 (1901).
11. Jr. prak. Chem. (2) 15, 28 (1877).

II. 0.4108 gram substance required 28.20 cc. $AgNO_3$ solution, representing 0.0984 gram Cl.

III. 0.3450 gram substance required 23.53 cc. $AgNO_3$ solution, representing 0.0821 gram Cl.

	Calculated for $Cl\text{-}SO_2\text{-}OC_2H_5$.	Found. I.	II.	III.
S	22.18	22.51	....	....
Cl	24.52	....	23.96	23.80

Chlorsulphonic ethyl ester is a colorless, limpid liquid, possessing a sharp, pungent odor, irritating to the eyes and exciting tears. Its boiling-point under a pressure of 14 mm. is 52°, and under 20 mm. 58°. The specific gravity is 1.3630 at 18°. It is soluble in ligroin, chloroform, and ether, but attacks ether when warmed. It is also soluble in fuming nitric acid, and is precipitated unchanged by the addition of water. Water affects it only slightly in the cold, even after standing with it for weeks; but on heating, decomposition quickly sets in. Thus, 4.8 grams of the ester heated in a distilling flask containing 40 cc. water, gave 150 cc. of ethyl chloride, or 16 per cent. of the theoretical amount. The decomposition of the ester by alcohol has been shown by Claesson to yield ethyl chloride, hydrogen chloride, ethyl sulphuric acid, ether, and a small amount of diethyl sulphate.

ACTION OF CHLORSULPHONIC ETHYL ESTER UPON SODIUM ALCOHOLATES.

1. Upon Sodium Ethylate. Twenty-five grams (2 mols.) freshly prepared sodium ethylate, dried at 180° in a hydrogen stream under reduced pressure, were suspended in 100 grams purified gasoline (b. p. 110°–125°). Twenty-five grams chlorsulphonic ethyl ester were slowly added by means of a dropping funnel, the mixture being continually agitated and kept cool in an ice-salt freezing mixture. After the ester had all been added, the temperature was allowed to rise to about 10°, and was kept there until the odor of the ester was no longer noticeable. The gasoline solution was then decanted, filtered, and subjected to distillation from a water-bath, and yielded ethyl ether, which after rectification weighed 2.85 grams. The residue of salts was washed with absolute ether and the washings were added to the gasoline from which the ether formed in the reaction had been removed as above described. On then removing the ether and gasoline by distillation at reduced pressure, 9.92 grams diethyl sulphate, distilling between 96° at 18 mm. and 96° at 14 mm., were obtained—a yield of 32.2 per cent. After being washed with ether, the salts were dissolved in water and the solution was saturated with carbon dioxide, then evaporated to dryness under reduced pressure. By digestion with absolute alcohol, 12.2 grams sodium ethyl sulphate were obtained

(47.6 per cent.) The residue, insoluble in alcohol, gave, on dissolving in water—acidifying with hydrogen chloride, etc.—2.05 grams of barium sulphate, which corresponds to 1.25 grams (5 per cent.) sodium sulphate.

2. Upon Sodium Isoamylate. ETHYL ISOAMYL SULPHATE, $C_2H_5O-SO_2-OC_5H_{11}$. Twenty-two grams (1½ mols.) sodium isoamylate, dried at 220° in a stream of hydrogen under reduced pressure, were suspended in 100 cc. absolute ether, and cooled in a freezing mixture of ice and salt, and 19.5 grams chlorsulphonic ethyl ester added; drop by drop. The temperature was allowed to rise slowly to about 15° and it was observed that the sodium isoamylate gradually dissolved, and that salt did not separate even after half an hour's standing at room temperature. On heating the mixture, however, under a reversed condenser, much salt was deposited. The ethereal filtrate was first distilled at about 100 to 150 mm. pressure in order to remove the excess of ether, the amyl alcohol, and amyl ethyl ether. The two last substances were formed in considerable amounts but were not quantitatively separated. The residual oil was distilled at about 18 mm. pressure; there was much charring with evolution of sulphur dioxide, but the distillate, after washing with dilute sodic hydrate and drying with calcium chloride, yielded 5 grams (37 per cent.) of pure ethyl isoamyl sulphate (described below). The salt residue insoluble in ether was worked up in the same manner as the salts formed from sodium ethylate, already described. The absolute alcoholic extract weighed 7.4 grams and proved to be sodium isoamyl sulphate, although possibly sodium ethyl sulphate may have been present in small quantity. Considered as sodium isoamyl sulphate, the amount found was 29 per cent. of the theory. The remaining salt residue yielded 6.88 grams $BaSO_4$, corresponding to 4.19 grams (21.8 per cent.) of sodium sulphate.

In a second experiment, 34 grams sodium isoamylate, 150 cc. ether and 30 grams chlorsulphonic ethyl ester were used. The ethereal solution was not heated under the reversed condenser, as in the preceding experiment, but on adding about 25 cc. of cold water a thick gelatinous mass of salts was precipitated, which dissolved on adding (125 cc.) more water. The ethereal solution was washed frequently with water, dried with calcium chloride, and subjected to fractional distillation under reduced pressure. The oil that remained after the removal of the amyl alcohol and amyl ethyl ether was, however, not directly distilled, but first again taken up in ether, washed with dilute caustic alkali, dried with calcium chloride, and then distilled at reduced pressure. Thus 20 grams (49 per cent.) of pure ethyl isoamyl sulphate were obtained.

0.4636 gram substance gave 0.5646 gram $BaSO_4$ (Carius).

	Calculated for $C_2H_5O-SO_2-OC_5H_{11}$.	Found.
S	16.34	16.72

Ethyl isoamyl sulphate is a colorless oil, resembling diethyl sulphate, but its odor is less agreeable, although somewhat like that of bananas. Its boiling-point was found to be 127–128° at 15 mm.; specific gravity, 1.079 at 20° (Westphal); index of refraction for sodium light, 1.4118 (Abbe). It is insoluble in and is not affected by cold water, but dissolves readily in alcohol, ether, and ligroin. Heated above 140°, rapid decomposition begins.

3. Upon Sodium Isobutylate. ETHYL ISOBUTYL SULPHATE, $C_2H_5O-SO_2-OC_4H_9$. Proceeding exactly as in the experiment last described, 25 grams (1.5 mols.) sodium isobutylate, freshly prepared and dried at 180°–190° in a stream of hydrogen under reduced pressure, were suspended in about 100 cc. absolute ether, and treated with 30 grams chlorsulphonic ethyl ester. On adding water to the clear ethereal solution obtained, a copious gelatinous precipitate was instantly formed. The products isolated were:

Ethyl isobutyl sulphate, 18.7 grams, or 50 per cent.

Sodium isobutyl sulphate, 9.6 grams, or 26 per cent.

Sodium sulphate, 3.2 grams, or 11 per cent.

The ethyl isobutyl sulphate obtained boils at 108° under a pressure of 13 mm. and possesses the specific gravity 1.098 at 23° (Westphal). Its index of refraction for sodium light is 1.4068 (Abbe). It is a colorless oil, insoluble in water, having an odor similar to that of mandrake. In a sulphur determination (Carius),

0.6276 gram substance gave 0.8183 gram $BaSO_4$.

	Calculated for $C_2H_5O-SO_2-OC_4H_9$.	Found.
S	17.60	17.90

4. Upon Sodium Isopropylate. ETHYL ISOPROPYL SULPHATE, $C_2H_5O-SO_2-OC_3H_7$. On treating 27 grams (2 mols.) sodium isopropylate, suspended in about 100 cc. absolute ether, with 22.8 grams of chlorsulphonic ethyl ester, the following products were obtained:

Ethyl isopropyl sulphate (crude oil), 16.2 grams, 62.2 per cent.

Sodium isopropyl sulphate, 7.5 grams, 29.3 per cent.

Sodium sulphate (not weighed).

Ethyl isopropyl sulphate is less stable than the other alkyl sulphates here described, and consequently there is much loss in distilling it even at reduced pressure. Its boiling point is 105° at 18 mm. pressure; the specific gravity, 1.143 at 21° (Westphal), and the index of refraction for sodium light, 1.4062 (Abbe). For the analysis a

distilled portion was taken up in ether, washed with dilute caustic soda, and dried with calcium chloride. The ether was then removed by heating to 60° in a vacuum.

0.4904 gram substance gave 0.6664 gram $BaSO_4$.

	Calculated for $C_2H_5O-SO_2-OC_3H_7$.	Found.
S	18.95	18.65

The sodium isopropyl sulphate obtained closely resembles sodium isobutyl sulphate in appearance, soapy feel, and solubility in water and alcohol. A portion of it was hydrolyzed by means of hydrochloric acid and the alcohol thus obtained boiled between 79.5° and 82°. This on oxidation gave acetone, as was proved by converting it into indigo by condensation with o-nitro benzaldehyde.

I wish to gratefully acknowledge that the results I have to present were made possible by my appointment, three years ago, to a fellowship in the University of Chicago. My work was, however, seriously interfered with by sickness, and is not yet completed.

SOME SANDSTONE WATERS OF GREAT PURITY.

By E. H. S. BAILEY, of Kansas University.

Read before the Academy, at Iola, December 31, 1901.

MANY attempts have been made to classify mineral waters, but as their composition is so complex, it is evident that any system that may be adopted will be somewhat defective. The simplest classification would be one that arranged in each group those waters having a predominance of similar constituents, or ions. The system which we have adopted is a modification of that proposed by some other chemists, and is as follows:

I, The Chloride group.
II, The Sulphate group.
III, The Chlor-sulphate group.
IV, The Carbonate group.
V, The Chlor-sulpho-carbonate group.
VI, The Sulphide group.
VII, The Chalybeate group.
VIII, The Special group.
IX, The Soft Water group.

It is my object to call attention to the last of these, the soft-water group. As such a large proportion of the rocks of Kansas are of calcareous origin, it is natural for us to infer that the waters are nearly all hard, from the presence of carbonates and sulphates of lime and magnesia. Fortunately, however, there are few areas where sandstone and other rocks prevail, and here we find excellent soft waters.

Among those that have been examined in the laboratory of the University, the following are worthy of special note; the amount of solid or mineral matter obtained in each case on evaporating a gallon of the water is expressed in grains:

Conway Springs	3.41	Delaware springs	8.27
Brookville No. 2*	3.84	Parker's	8.89
California	6.13	Linwood*	9.90
Cave spring	6.75	Chico spring	14.92
Brookville No. 1*	8.09	Kansas Clarus	20.83
Sand springs*	8.15		

*Carbon dioxide to form bicarbonates is not included.

These springs either flow from sand or from beneath sand rocks. These rocks often contain considerable iron and a little of this is almost always found in these waters. With the exception of the water found near Brookville, and that of the Conway Springs, the California spring contains less mineral matter than any that has been analyzed.

The California spring is said to have derived its name from its

situation on one of the numerous trails leading across the state to the mountains and to California. It is situated on the southern slope of the broad valley of the Marais des Cygnes, about four miles northwest of Ottawa. The temperature of the water is 58° F., and the flow is 450 gallons per hour. There are no rare constituents in the water, as the following analysis shows:

Grams per liter.

IONS.		RADICALS.	
Sodium (Na)	.0068	Sodium oxide (Na_2O)	.0092
Calcium (Ca)	.0146	Calcium oxide (CaO)	.0205
Magnesium (Mg)	.0018	Magnesium oxide (MgO)	.0031
Iron (Fe)	.0004	Iron oxide (FeO)	.0005
Chlorine (Cl)	.0106	Chlorine (Cl)	.0106
Sulphuric acid ion (SO_4)	.0074	Sulphuric anhydride (SO_3)	.0062
Silicic acid ion (SiO_3)	.0238	Silicic anhydride (SiO_2)	.0180
		Carbonic anhydride (CO_2)	.0327
		Water (H_2O)	.0067
		Oxygen equivalent	.0024
		Total	.1051

Hypothetically combined as follows:

	Grams per liter.	Grains per gallon.
Sodium chloride (NaCl)	.0174	1.018
Calcium sulphate ($CaSO_4$)	.0106	.618
Calcium bicarbonate ($CaH_2(CO_3)_2$)	.0466	2.721
Magnesium bicarbonate ($MgH_2(CO_3)_2$)	.0113	.661
Iron bicarbonate ($FeH_2(CO_3)_2$)	.0012	.071
Silica (SiO_2)	.0180	1.049
Totals	.1051	6.138

There is a demand for waters that are extremely pure in the treatment of certain diseases where an abundance of mineral matter is injurious. This water contains very much less solid matter than such waters as the Waukesha, Jackson Lithia, etc. waters that are recommended more for their purity than for any special ingredients that they contain. There are waters found in the sandstone and granite regions of the East that are as pure as the California spring, and some actually contain less than two grains per gallon, but it is interesting to notice that we have in the middle West just as good waters, and that they are abundantly supplied in certain localities.

III.

GEOLOGICAL PAPERS.

"The Spanish Peaks."
By J. J. Jewett, Topeka.

"Economic Geology of Iola and Vicinity."
By G. P. Grimsley, Washburn College, Topeka.

"Notes on the Geology of the Antelope Hills."
By R. S. Sherwin, University of Oklahoma, Norman, Okla.

"Notes on the Theories of Origin of Gypsum Deposits."
By R. S. Sherwin, University of Oklahoma, Norman, Okla.

"Experiences with Early Man in America."
By Charles H. Sternberg, Lawrence.

"The Permian Life of Texas."
By Charles H. Sternberg, Lawrence.

"Geology of Lyon County, Kansas."
By Alva J. Smith, Emporia.

"Further Studies of the Mentor Beds."
By Alfred W. Jones, Kansas Wesleyan University, Salina.

"The Ottawa Gas-wells."
By J. A. Yates, Ottawa University, Ottawa.

"Physiographic Divisions of Kansas."
By Geo. I. Adams, Washington, D. C.

"List of Fossil Plants Collected in Vicinity of Onaga, Kan."
By F. F. Crevecœur, Onaga.

"Gold in Kansas." (Two papers.)
By J. T. Lovewell, Topeka.

THE SPANISH PEAKS.

By J. J. JEWETT, Topeka, Kan.

WHERE glacier gleamed, a jeweled precipice,
With torrents pouring from its blue abyss,
Before Niag'ra had begun to trench
Its channel through Ontario's rocky bench,
I stand, and view a river's whirling flood
Fall seaward with its tinge of tribute mud.

I marvel if, again, the ice will gleam
A thousand feet above the turbid stream.
A city rests upon the glacial grist,*
With towers and spires the blessed clouds have kissed:
Its smoke, and steam, and screeching sounds of power
Proclaim its Kings of Toil rule every hour.

I wait the dark, one-eyed, steam-spirit steed,
That dares essay the black tornado's speed:
I mount a carriage gorgeous with plush:
A bell is rung: a thousand people rush
This way and that: the city vista yields
To farms well tilled and ample pasture fields.

The westward train th' ascending prairie streaks,
And far southwest reveals the Spanish Peaks,
That tower above the earth-curve of the plain
As shipmasts loom above the convex main,
While yet the bulky body of the ship
Lies hid below the dim horizon dip.

In sooth they seem a ship in steady sail
Across a swardy sea of swell and swale,
Above the panorama, boundless stretched,
Of moveless troughs and billows Time has etched
With wind and water, frost and acid gas,
And clothed in herbage decked with plumes of grass.

---

*The situation is applicable to Topeka, Kan., or to Kansas City, Mo.

The Spanish Peaks are situated on the south border line of Huerfano county, in southeastern Colorado. The west peak, on the authority of Hayden, is 13,620 feet high; but Wheeler found it to be 100 feet higher. The latter altitude is that which is generally accepted. The summit of the west peak is about 7000 feet above the low hills adjacent, and about 8000 feet above the surface of the plain fifteen to twenty miles distant. The east peak has 1000 feet less altitude. The summits of the peaks are about three miles apart. Owing to the absence of surrounding mountains the peaks are more conspicuous than Pike's Peak, although the latter is more than 400 feet higher than the west peak. The Santa Fe and the Missouri Pacific roads afford westward tourists views at a distance of ninety miles and under. R. C. Hills (Proc. Colo. Sci. Soc., 1890) says the peaks are "natural lightning-rods," and fulgurites abound upon them. He classes the peaks as laccolithic eruptions, and states that the west peak carries a large mass of metamorphosed sedimentary rock. Hayden and Endlich regarded the peaks as an enormous dike. Prof. I. C. Russell (Volcanoes of North America) says they are the "roots" of vast, extinct volcanoes. All are agreed that they are the product of Tertiary times. The coal-beds of the region are of the Laramie formation.—J. J. J.

Above their base two thousand meters high—
Gray silhouettes—they jut against the sky,
Yet eighty miles away, as flies the crow.
Are they not clouds on the horizon low—
Not rocky masses from the Earth's hot breast,
By forces measureless and ceaseless pressed?

I watch and wait, till o'er the rails of steel
Leagues have been traversed by the iron wheel,
And still the twins remain unchanged and grand,
Like Egypt's pyramids amid her sand.
I know they are not clouds—that cannot be!
Else, sun-warmed, they would change their forms or flee.

A league of mountain ridge the twain unites
(Like Chang and Eng), below their shoulder heights,
Extending east and west; but Earth is curved,
And far away this wall is unobserved:
All round these yoked yet isolated mounts
Is broad plateau, the traveler recounts.

How come these trachyte cones to stand aloof
From mountain range, to Time's sharp trencher proof?
Methinks I hear the voice of Science, now,
Say: "List, attentive! I will tell you how:
For I have been with Nature, and have sought,
In her own diary how she has wrought.

"There she has written births and epitaphs:
Has printed pristine, cryptic lithographs;
Engraved with fire, and frost, and sanded blast;
And pages bossed with shell and metal-cast.
Though she, at times, has torn her books apart,
And crumpled up their leaves afresh to start.

"These have I studied and interpreted.
Nature still works and writes as I have read,
And constantly, but so exceeding slow,
That in a chapter ages come and go.
Her latest tome, her very newest page,
Repeats the story of a former age.

"Her records show no date, no year of prime,
To separate Eternity from Time;
And yet, her labors, in succession done,
Go back, in terms of time, to when begun.
Perchance the index of her present acts
Will point the centuries of ancient facts.

"But this is what her records do aver,
About the Peaks, of things that are and were:
Beneath the surface of the bord'ring wold
Are fallen forests, piled a thousand fold,
And crushed by massive sheets of rock o'erlaid,
And charred to blackness by the pressure made.

"Below the wide expanse of forests charred
Are beds of rock, in layers soft or hard,
Formed on the basement of a sea now gone,
Of substance shorn from land no sea was on:
For, always, has the sea its basement strown,
With shearing of the land, and made it stone.

"Miles thick the sea built up, lay over lay,
With sand, and lime, and iron-rust, and clay:
And forms of life from flooded plains and glens,
And countless millions of her denizens
She felted in the tissue of her spreads
To mark the ages of successive beds.

"So, then, the rocks beneath the plain were built
From older rocks dissolved to grit and silt.
As life from older life is ever sprung,
As ancient forms must pass away for young,
Even the Earth itself will pass from view,
And, as it has been, Earth be formed anew.

"The ancient sea-floor most unsteady was—
It rose and fell, yet not without a cause:
If one shall press upon a plastic ball,
Elsewhere 't will bulge, if it shall yield at all:
So, when some heaviest portion of Earth's crust
Shall sink a little, rise the lightest must.

"And so, at times, the sea-floor rose to air,
For, when the bottom of some sea elsewhere,
More burdened with the waste of continent,
Sank somewhat lower, this one was upsent.
Again, when overfreighted with debris,
Down, also, went the bottom of this sea.

"And some old land that Time had weather'd light
Was slowly lifted to a greater height.
It ever was, and will be time to come,
Things sought, and will seek, equilibrium.
And thus, alternate, up and down they swing—
The land and sea—like scale-pans balancing.

"It came to pass the sea itself was drained,
And in its place a wide champaign remained.
It came to pass the plain became a lake,
With many a ferny, many a reedy brake:
Titanic monsters wander'd round its brink,
And five-toed horses daily came to drink.

"The ages came and lapsed: It came to pass
The lake was banished for a vast morass,
Where matted vegetation turned to peat:
Trees, sedges, mosses, piled a thousand feet,
Were massed, till future tides above should roll,
And weight of rock should press them into coal.

"It came to pass the sea again o'erflowed;
The marsh went downward with its carbon load.
Some mountain, gable-roofed, had raised its crest,
And lesser weight beneath its cover pressed:
Plutonic magma rose to fill the space,
And let the sea resume its ancient place.

"The Earth forever shrinks upon its core:
'T is shrinking now, as it has shrunk before:
Its skin (to Earth a hairbreadth to an inch),
In folds and wrinkles shows the mighty pinch:
Its strength is weaken'd where 't is often bent,
Between the highland and the sea's descent;

"And as it shrinks to less and lesser girth,
Up bursts some inner matter of the Earth.
Now, where the Spanish Peaks are was a coast,
Along which line the crust was weakened most.
When unfledged ages passed to ages flown,
And Earth had very little cooler grown,

"Its crust, more shrunken than it e'er had been,
Exerted greater stress on things within,
And forced up, as it were a drop of paste,
From out the vastness of the mass encased:
That viscous drop the Spanish Peaks became—
To man a lofty, awe-inspiring frame.

"The hot mass on its shoulders bore a cloak,
From sea-constructed rock through which it broke,
And, like a huge cephalopod, it thrust
Its tentacles through fissures in the crust,
Which its own violence had opened wide,
In radiating lines on every side.

"It pushed its feet between the sheets of rock
The sea had laid, as if its work to mock:
It formed its skirt of rent and angled parts,
And challenged clouds to hurl their lightning darts.
The clouds were willed to wage a furious war;
To them were wind and frost allied that for:

"Ten hundred thousand years the battle raged,
And still the allied forces are engaged.
Earth sent up reinforcements to its own;
Dike after dike gave to it bulk and bone,
Until 't was braced with ribs throughout its form,
And raised its taunting heads above the storm.

"And still the elements beat, day by day:
A thousand meters' height has worn away;
Its cloak is but the remnant of a wrap,
Its skirt has wasted to a ragged scrap.
Ten billion tons of snow and ice it 's held;
Ten billion tons of water has repelled.

"Ten million thunderbolts with jagged points
Have penetrated through and through its joints.
It yet defies its old, immortal foes,
And tranquilly receives their puny blows.
Yet will the potent princes of the air
This two-crowned monarch into atoms tear:

"The frost will flake, the ice will grind and grate,
The lightning decompose and dissipate;
The winds will etch it, solvent rains descend:
Though rock, on rock foundation, it will end.
It will be moved—yet not through human faith,
But consciousless, persistent, certain, scathe—

"And in the sea be cast, in time to be—
That Time will be—Time is Eternity.
Then will this prairie have been scraped and scored—
Perhaps below the ocean's level lowered:
No continent forever will endure;
No star or moving planet is secure.

"The Universe, in every part, will change;
Yet, not a whit from Nature will estrange;
Nor can there be what can annihilate
The potencies and portions that create
The forms that are (though forms that are shall flit),
For force and matter are the Infinite."

ECONOMIC GEOLOGY OF IOLA AND VICINITY.

By G. P. Grimsley, Washburn College, Topeka.

Read before the Academy, at Iola, December 31, 1901.

NO city in Kansas can display a greater variety of mineral interests than Iola. It is then very fitting that the first annual meeting of the Kansas scientists in the new century should be held in this center of industrial activity. Here may be seen one of the most complete cement plants west of the Mississippi, the largest number of zinc-smelting retorts in the United States, yielding one-half the total production of spelter in this country, the largest natural-gas engines constructed, probably the only sulphuric-acid works in the world where natural gas is used in reduction, and some of the model brick plants of the state. Here a quiet village of 1500 has changed in six years to a city of 8000, with a monthly pay-roll of $100,000, the result of natural gas and the energy and hustle of competent and foresighted business men. Recently Iola has constructed an eighty-thousand-dollar water-works and electric-light plant. An electric railroad is now in operation, with cars running from the Neosho river, through Iola, to Gas City, Lanyonville, and La Harpe, representing an investment of $150,000.

Outside of the mineral industries to be described, there are a number of important manufacturing plants at Iola, including the ice plant of the Iola Ice and Cold Storage Company, with a daily capacity of fifty tons, an iron foundry, a planing-mill, a creamery with a capacity of 1000 pounds a day, flour- and feed-mills, and a sawmill. These mills and factories alone would give Iola high rank as a manufacturing city, but they are overshadowed by the larger mineral industrial work.

Natural Gas. The motive power for these various lines of manufacture is natural gas. Thirty years ago the Iola gas-sand was first pierced by the drill, in the old well, known to this day as the Acres mineral well, a sure cure for the ills of man. Its real value, however, was not recognized until the Ohio and Indiana gas was developed, in 1886; then the Iola Gas and Coal Company was organized and several wells were drilled, with poor success.

In 1889 Pryor and Paulin took charge of the work and drilled six additional wells, with about the same success; but near the end of 1893 a great flow of gas was struck, yielding three million cubic feet per day. In 1896 the company was changed, and became the Allen County Gas Company, and later, consolidated with the Cooperative Company.

formed the Iola Gas Company, which now supplies gas to the different parts of the city.

In 1894 the Palmer Oil and Gas Company, of Fostoria, Ohio, entered the field and leased about 45,000 acres. Their first well was drilled in August, 1894, and in the next three years they drilled fifteen wells, of which nine were productive, with a daily capacity varying from two to twelve million cubic feet, or a total of about fifty-eight million cubic feet, equivalent to nearly 3000 tons of coal. The holdings of this company in March, 1899, were transferred to the Lanyon Zinc Company, the gas-field still remaining under the able superintendence of L. C. Beatty, who came to Iola with the Palmer company. The company now has forty producing wells, yielding not far from 125 million cubic feet of gas per twenty-four hours, equal to 6200 tons of coal.

The Iola gas-field covers an area twelve by six miles, with over seventy producing wells. The first wells were drilled to a depth of 500 feet, while the later ones were sunk from 815 to 920 feet. The reservoir in the field is a porous sand, found in the Cherokee shales of the Lower Coal Measures, 20 to 150 feet in thickness. The rock pressure of the gas as measured by a gauge is 315 pounds to the square inch, or equivalent to twenty-one atmospheres, and this is the motive power which sends the gas out of the well and through the pipes. The open-flow pressure is about thirty-five pounds, and represents the volume. The Iola gas and the gas of the other districts in Kansas is remarkably pure, containing no sulphur or phosphorus, and can be used for any manufacturing purpose. The gas is supplied to the citizens at a cost of one dollar a month for each stove, and ten cents each for the first two lights and five cents for every additional light. It would be difficult to give the exact amount of gas used in twenty-four hours from the Iola field, but it certainly is not far from 12 million cubic feet, or equivalent to 600 tons of coal.

Brick Manufacture.—Natural gas furnishes a cheap and convenient fuel for burning brick, and Iola is surrounded by good brick shales. At the present time there are two companies, with three yards. Plant No. 1 of the Iola Brick Company is located one mile east of the center of town, and has a capacity of 40,000 brick daily. Their plant No. 2, just south of town, has a daily capacity of 60,000. Near the latter is the plant of the Star Brick Company, with a capacity of 25,000.

In southeastern Kansas, there are ten brick plants using natural-gas fuel, and three in the coal belt. All of these are running night and day, and cannot keep up with orders. New plants are being constructed, and in a short time Kansas will be well to the front rank as

a brick-producing state. The Iola brick-yards are equipped with the best of modern machinery, and manufacture building brick, dry pressed brick, repress brick, in pleasing and durable shades of color. They are shipped to Kansas City, Arkansas, Oklahoma, and various cities of Kansas.

ZINC SMELTERS.—For many years the zinc-smelting industry of the southern Mississippi valley centered in the Kansas coal district of Pittsburg and Girard. In 1896 a smelter was built at Iola by the Robt. Lanyon's Sons' Company, of Pittsburg; a thousand retorts were soon installed, and the experiment tried of using natural gas for fuel. The work was so successful that the smelters were removed to the gas belt, and new companies organized, so that the industry now centers at Iola and Cherryvale. Kansas has now become the leading zinc smelter state of the Union, going from second rank to first.

The process of treatment of the zinc ores is briefly as follows: After the sulphur is removed by roasting, the fine ore is placed in clay retorts, which are cylinders of fire-clay four feet long and eight inches in diameter, closed at one end. These fit in openings in the walls of the furnace, with the open ends flush with the walls, and are arranged in rows forming a block. When coal was used for fuel, 224 retorts were placed in a block, while with gas about 600 can be placed in one block. When charged with ore, a condenser, a conical fire-clay vessel, about twelve inches long and six inches in diameter at the larger and two inches at the smaller end, is so placed that the larger end just enters the open end of the retort.

As the ore mixed with powdered coke is heated the zinc is driven off as heavy vapor, which forms in drops on the inside of the condenser, from which the metal is tapped in long ladles about three times in twenty-four hours. The molten metal is emptied into a traveling kettle and poured into molds about $9 \times 19 \times 1\frac{1}{4}$ inches, making a fifty-pound plate, known as "spelter."

The zinc-works make their own retorts and condensers, out of good fire-clay mixed with one-third its weight of fragments of old retorts pulverized. The materials are mixed in a pug-mill with water and then passed through a molding machine, and afterward dried in a heated room for some weeks. They are finally fired in a small furnace for twelve hours. The condensers are made in hand molds as needed.

At the present time, at Gas City there are three smelters—Prime Western, with three blocks or 2000 retorts; Cherokee-Lanyon, with three blocks; A. B. Cockerill, with three blocks.

At Lanyonville, the Lanyon Zinc Company has a smelter of five blocks and a zinc rolling-mill. At Iola is the Nicholson smelter of five blocks, the Wm. Lanyon smelter with three blocks, the two smelt-

Shale Pit of the Iola Brick Company, at Iola.

ers of the Lanyon Zinc Company of twelve blocks. This gives a total of about 20,000 retorts, giving a daily capacity of over 300 tons of spelter, requiring nearly 700 tons of ore.

SULPHURIC-ACID WORKS.—The new plant of the Standard Acid Company, now in active operation, is located just east of town. The zinc ore is roasted in mechanical continuous roasters composed of a seven-row muffle kiln, capable of roasting sufficient ore to run a three-block (1800 retorts) smelter. The sulphur fumes pass into a flue where the dust is deposited, and the sulphur gas passes to a square condensing tower, forty-nine feet high, and the heat of the gas is used to concentrate the weaker acid. The gas is then carried through a three-inch pipe into six chambers connected tandem, 150 feet long, 20 feet high and wide, and in these condensation takes place. Into these chambers exhaust steam is admitted, and the gas passes into two absorbing towers lined with lead and filled with a checkerwork of chemically prepared bricks, where the nitrogen compounds are recovered. These were added in the condensing tower in the form of nitric acid, to furnish oxygen.

In the lead-lined chambers the steam and sulphurous gas unite and form sulphuric acid. From the condensing towers the acid passes through lead coolers, kept cool by flow of water, and it is then pumped into storage tanks and run into tank cars of 65,000 pounds' capacity. Twenty of these cars have been constructed for this work.

The buildings cover twenty acres of ground. The main building is 526 feet long, 65 feet wide, with an L of 111 feet, and is 70 feet high. The plant will treat forty-five tons of ore a day, yielding fifty tons of acid. The acid will be used in the manufacture of fertilizers, refining of petroleum, alum, soda-ash, blue vitriol, etc. This is probably the only plant in the United States manufacturing sulphuric acid where natural gas is used as fuel. It is the second plant established in Kansas, the other being located at Argentine.

The sulphur vapors, so destructive to the vegetation around the smelters, are now to be made of economic importance, and, with the exhaust steam, furnish material which would otherwise go to waste.

PORTLAND CEMENT.—The only Portland cement mill in the state is located at Iola, and it has now been in successful operation for two and a half years, turning out a quality of cement equal to the best foreign cement. Natural gas is the fuel used to drive the engine, to dry the material, and to burn the cement. The largest gas-engines in this section of the country are to be found at Iola. There are six 300-horse-power Westinghouse gas-engines and five 150-horse-power. The aggregate horse-power now used is 2600. About 1000 tons of

limestone are used in twenty-four hours, giving a daily production of 3500 barrels of cement.

Tests show a remarkable strength of product; neat briquettes have a strength of 800 to 1000 pounds after twenty-eight days, or with three parts sand have a strength of from 400 to 500 pounds, and ninety-five per cent. passes through a No. 100 sieve. This is brought about by careful manipulation and watching on the part of experts employed by the company. All mixtures are carefully examined, and tests are made at various stages of the manufacture, so as to secure a uniform product. The physical and chemical laboratories are thoroughly equipped, and three chemists are employed.

The mineral industries of Kansas must be seen to be appreciated, and, through the kindness of the citizens of Iola, the Kansas Academy of Science, composed of members interested in the scientific progress of the state, has been able to see a great industrial center and to become acquainted with the progress here shown. The members appreciate this opportunity, and will watch the growth of Iola in the future with new interest, and they will always carry a pleasant memory of the thirty-fourth meeting, at Iola.

NOTES ON THE GEOLOGY OF THE ANTELOPE HILLS.

By R. S. SHERWIN, University of Oklahoma, Norman, Okla.

Read (by title) before the Academy, at Topeka, January 2, 1903.

THE Antelope Hills form the most conspicuous landmark of western Day county, in Oklahoma. They are outlying remnants of an old plateau, probably of Tertiary age, situated on the south side of the South Canadian river, on the inside of a large bend. The distance of the river from the hills varies from about two miles on the west to ten on the north and four or five on the northeast. In general outline, the drainage of the area around the hills and inside the bend of the river resembles an open fan.

The following section was taken on the largest of the buttes:

4.	Gentle covered slope at top	25 feet.
3.	Gray sandstone	25 "
2.	Sand or saccharoidal sandstone	30 "
1.	Long covered slope to the river	460 "
	Total	540 feet.

On top of the hills and near them were found many pebbles of flint, limestone, and several igneous rocks, including lava. The cementing material of the sandstone is calcium carbonate. The amount of it varies greatly, and it is sometimes found in concretion-like forms which contain comparatively little sand. These concretions weather out very unevenly, and give the edge of the sandstone the appearance of being covered with stalactites. Some of them are larger than a man's arm, while others are small. The soft saccharoidal sandstone below the cap-rock differs from it only in having less of the cementing material. The little that it does contain is irregularly distributed. Even in the sandy slopes and in the soil lower down, there are small concretions of carbonate of lime. A few scattered buffalo bones were found on and near the hills, and some fragments of larger fossil bones were found on the southwest slope of the largest butte.

Locally the two hills farthest east are known as the Twin Hills, because they are so nearly alike, and about three miles from the other four, which are called the Antelope Hills. None of them have any timber except a few crooked cedars around the edges. The area of the top of the largest butte is probably less than thirty acres, and the total area of the tops of the group would hardly exceed sixty acres. There is a small spring of good water at the base of the largest one, and a larger one about a quarter of a mile from the Twin hills.

The cap-rock of the Antelope Hills is at about the same level as the

top of the sand-hills which cover a large part of northern Day county, and differs only in having the cementing material. The fact that the Antelope hills can be seen for a long distance depends more on the height of the broad, gently sloping base than on the height or size of the steeper portion at the top. South and southwest of the buttes there are lower hills, rising with gentle, rounded slopes, and covered with a sandy soil. The whole appearance of the surrounding country seems to indicate that there was a local hardening in a Tertiary sand plain by the deposition of calcium carbonate in it. Later the South Canadian river cut though this plateau, making a bend to the north around the hardened part. Erosion went on rapidly in the loose sand near the river, but was checked by the hardened layer. Finally, the hardened portion was cut into several parts and left only in the tops of a few buttes which it still protects.

NOTES ON THE THEORIES OF ORIGIN OF GYPSUM DEPOSITS.

By R. S. SHERWIN, University of Oklahoma, Norman, Okla.

Read before the Academy, at Iola, December 30, 1901.

SEVERAL different theories have been given to account for the origin of gypsum beds, but the one which is most generally accepted for the formation of the gypsum of Kansas and Oklahoma is that of evaporation of water in an inland sea. When sea-water is evaporated gypsum is deposited, and if the evaporation is continued a heavier deposit of salt is obtained.

The substance of the argument in favor of this theory is that the gypsum is often more or less closely associated with salt, and that the composition in many cases is similar to that of the material obtained by evaporation of sea-water.

Some idea of the amount of water which must have been evaporated during later Permian times in Kansas and Oklahoma, according to this theory, can be obtained by calculations based on the composition of sea-water. It is improbable that sea-water ever contained a larger percentage of gypsum than it does at present; so the estimates of the amounts of water are not likely to be too high.

According to the most reliable analyses,[1] sea-water contains 3.5 per cent. of mineral matter, of which 3.6 per cent. is calcium sulphate. Ordinary rock gypsum contains about 21 per cent. of water of crystallization, as expressed by the formula $CaSO_4 + 2H_2O$. Taking this into account, the amount of gypsum contained in sea-water is about 0.16 per cent. The specific gravity is given[2] at from 2.28 to 2.31. Using the lower figures, the thickness of the layer of pure rock gypsum which could be deposited from a body of water one foot in depth is a little less than .0007 foot. It is stated that the process must have been continuous in Kansas while at least eight or nine feet of rock gyysum was being formed. Taking the lower estimate, the amount of water which must have been concentrated during the period of continuous deposits of gypsum was the equivalent of a sea or lake more than 11,000 feet deep, and covering the area over which the deposits were made.

As it is unlikely that an inland sea with a depth of two miles was cut off and evaporated sufficiently to deposit all of its gypsum, some hypothesis must be brought forward to show how this enormous amount of water could have been supplied. It is possible to conceive

1. Challenger Reports, Encycl. Britt., article "SEA."
2. Univ. Geol. Surv. of Kan., vol. V, pp. 22, 80.

of a large basin, shallow except in the area where the deposit was formed, and to suppose that as the water was concentrated it retired into the deeper part. and that the salt already deposited was washed down with it.

Or the water might have been supplied by flowing in over a bar at a rate about equal to that of evaporation. Some water must have been furnished by the streams which carried in the clay that is found in irregular layers in the gypsum, but, unless there was some source of gypsum aside from sea-water, these streams would add very little to the amount of gypsum, and they would increase the amount of water to be evaporated.

In whatever manner we suppose the water to have been supplied. the real difficulty in the way of the evaporation theory is that of accounting for the concentration of such enormous amounts of water within a comparatively short time. The depth of two miles given above for the inland sea is for a layer of rock gypsum only eight feet thick; and as the total thickness in many places is at least four or five times as much, besides an unknown amount taken away by erosion, the water evaporated during later Permian times cannot have been much less than the equivalent of a sea eight or ten miles deep over the area where the heavy deposits of gypsum are, or where they have been removed by erosion.

In order to produce the necessary concentration, the surface of the gypsum sea must have been subjected to a dry climate; but the presence of mud and sand is evidence that the neighboring land was not so arid as the hypothesis seems to require. There is very little evidence that an inland sea of any great size existed in that place in Permian times. The hypothesis of an inland sea seems to have very little foundation except the hypothetical evaporation of water for the formation of gypsum and salt beds. There is no great unconformity such as must have resulted if the land to the west had been extensive enough to produce the necessary climatic conditions. "The Colorado plateau was a sea bottom continuously, or nearly so, from the beginning of the Carboniferous to the end of the Cretaceous."[3] If an inland sea of any great extent had existed in Kansas, Oklahoma and Texas during Permian times, and had been surrounded by a sufficient area of land to produce such evaporation, there would be a general absence of Permian rocks in the mountains west of the gypsum area.

If we accept the evaporation theory, the existence of different layers of gypsum alternating with other rocks requires us to suppose that the crust movements were extremely complex. We must suppose that inland seas were formed many times in succession in the

3. Le Conte, "Earth Crust Movements and their Causes," Smithsonian Report, 1896,

same place and then drained at the right time to deposit most of their gypsum and little of their salt. It is true that the gypsum area contains some salt, which is so soluble that it is difficult to imagine any way other than evaporation in which it could have been laid down, but the salt beds do not require the supposition of such a series of concentrations on a vast scale. Sea-water contains seventeen times as much sodium chloride as calcium sulphate, and the thickness of the salt beds is almost insignificant in comparison with the gypsum.

Taking all these things into consideration, it seems that a small part of the gypsum closely associated with the salt may have been deposited by evaporation, but there must have been some other source for the massive rock gypsum.

A saturated solution of calcium sulphate and a saturated solution of sodium chloride do not give any precipitate when they are mixed; so the gypsum could not have been precipitated by the salt in the ocean.

Large amounts of limestone have been removed from the land east of the gypsum beds. This erosion was going on in Permian times, and the lime must have been redeposited somewhere. The most natural place to look for it would be on the western coast or marginal sea bottom of that time. It is possible that the whole of the Red Beds underlying the gypsum was formed at or near the advancing shore line. This would account for the ripple-marks and for the presence of so much sand, either alone or mixed with clay and other material.

One of the properties of sulphides, especially of the alkalies and alkaline earths, is the readiness with which they take up oxygen and form sulphates. Springs containing soluble sulphides are not very common, but there is at least one in Indian Territory,[1] and it is probable that there are others in some parts of the plains. There may have been more such springs in earlier times, or there may have been sulphur gases in contact with some strata. The Permian age is supposed to have been one of disturbance and crust movements, and therefore there may have been more sulphides and sulphur gases in the springs or in contact with the strata below the surface than there are now. If any sulphide existed, either in springs or in the soil which was being eroded, a part of it would have been oxidized to a sulphate and carried away by streams along with the limestone and other material. The limestone, whether in solution or not, would be changed to a sulphate and deposited as a sediment of gypsum at the seacoast.

The gypsum would follow the general laws of sediments, and the amount would depend on the amount of sulphides or sulphates and

[1] Sulphur Springs, Chickasaw Nation, I. T.

on the character of the strata being eroded. Hence there might be all gradations from gypsiferous shales to pure gypsum. At some time the limestone might not have been changed to gypsum and beds of limestone, dolomite or calciferous sandstone would be formed, mixed or interstratified with clay.

Field south of Iola, in 1898, where the Iola Portland Cement Mill was erected in 1899 and 1900.

EXPERIENCES WITH EARLY MAN IN AMERICA.

By CHARLES H. STERNBERG, Lawrence, Kan.

Read before the Academy, at Topeka, January 1, 1903.

AS there are constantly, at present, newspaper stories of early man, based on the remarkable relics found in the river drift near Lansing, it has occurred to me that it might be of interest to tell of some of my experiences in a much older field, as well as a discovery I made that I have always considered of great scientific value, in the Pleistocene of Washington. As I will be obliged to repeat what I have to say on "Pliocene Man" from a paper I wrote for *Popular Science News*, I will first speak of Pleistocene man in Washington.

In the winter of 1877 I learned from an army surgeon that a great excitement had occurred in the Pine creek region of eastern Washington by the discovery there, in what the natives call mud springs, of some well-preserved skeletons of the hairy mammoth. I started at once for that field, and learned that a man who had lost a cow had followed the usual custom of probing with a long pole the various springs on his range, in order to see whether she had gone into one, and thus avoid the necessity (if she had) of making a long tramp in search of her. The point of his pole seemed to enter a small hole, like the occipital foramen of a large skull. He had some grappling-hooks made on the end of a strong iron rod, and with the assistance of his neighbors dislodged the skull, for so the object proved to be when brought to the surface. The huge proportions of the skull astonished the whole country round. A showman chanced to be in reach, and, during the high tide of popular wonder, purchased it for the snug little sum of $1000, put it under canvas, and realized rich returns from his venture. The men in the vicinity concluded there was a greater fortune in draining their swamps and exhuming extinct elephants than in raising wheat, and so went to work as fossil-hunters. One man, I learned, mortgaged his farm to raise funds for draining a large swamp on his place, and got a fine collection of these extinct creatures. But the popular excitement had ebbed, and there was not a convenient showman around to invest in elephant bones; so he was forced to place them on exhibition at a college in Forest Grove, Ore., receiving in return the free tuition of his son. Of course he lost his farm.

I at once, after looking over the ground and selecting a site, with the assistance of two men, began the work of draining a spring a few yards from Pine creek. Here, as in all the swamps in the region,

was an open place, circular in form, filled with soft mud. The edges were composed of peat moss. After penetrating this we passed through compact yellow clay, and twelve feet below was a bed of gravel, in which the bones were entombed. As the mouth of the spring was only two feet higher that the creek, we could only drain our spring to that depth. Every morning the water was up to this level, and we had to spend the greater part of the day in bailing out the mud and water; the little excavating we could accomplish added to our labors the next day, as we had more water to bail out. We worked for weeks in this way, and at last were rewarded, not with bones of the mammoth, as we hoped, but a number of skulls of the American bison, or buffalo. As they represented larger animals than the buffalo of the plains with which I was familiar, I supposed them to be extinct forms. Prof. E. D. Cope, however, assured me they belonged to the common living species. In one of these skulls I found an arrow-point of flint roughly worked. To my mind this was an important discovery, as the elephant bones were in this same bed of gravel, and I saw on the discarded dumps of the farmer fossil-hunters not only discarded elephant bones, but those of this same buffalo as well. So my discovery proved that man, the buffalo and the hairy elephant were contemporary in Washington. At what time is a harder problem to solve, but I saw remarkable evidence that it was long ago this gravel-bed was laid down, for I found in Oregon, under about 2000 feet of lava, this or a similar deposit of gravel, with the bones of the same variety of buffalo I found on Pine creek, in Washington. This discovery did not appeal very strongly to the imagination of Professor Cope, and I have never known whether he published a record of it or not. Possibly the great age of the buffalo on our continent was new to science: the fact that man and the great northern elephant existed at the same time was well known years before. Especially do the records of the icy barriers of the region towards the north pole bear incontestible evidence of this fact. Man was so familiar with this huge animal that he carved his likeness on its ivory.

I think this discovery is worthy of note, as it extends the southern range of man himself into the United States. When in 1894 I discovered the large deposit of teeth and bones of the mammoth in Lane county, remembering my experience in Washington, I searched carefully for human bones or implements associated with them, but without success. I would like to have been able to extend man's journeys from Washington into Kansas. Very likely the man whose skull was found at Lansing often saw droves of these great elephants.

I will now pass on to "Pliocene man." An article under this

head appeared in the American Naturalist in 1877. The whole is enclosed in quotation marks, and was a copy of a letter I wrote to Prof. E. D. Cope from a locality I named Fossil lake, in the desert of eastern Oregon—a name it still retains. I was sent there by the professor in August of that year. My letter of instructions advised me to look for human implements mingled with the extinct animal remains I was sent in search of; to write at once if I found any, their manner of occurrence, etc.

As one part of the story of the Pliocene man was told in the article, and as I was really the author of it, though my name does not appear, I have often felt it my duty to tell the end also, which, in this instance at least, proved to my mind that I was entirely mistaken in regard to man being contemporary with the Pliocene animals, birds and reptiles that I found so abundant at Fossil lake. I was young, and anxious to be able to say that I was the first collector to find traces of man so far back in the world's history, associated with the extinct horse, llama, elephant, etc. But I was also conscientious, and wrote the professor of the discovery I made later, which I am about to relate.

When I arrived one evening at the famous lake, after traveling across half the continent to find it, you can imagine I was too anxious to look for specimens to think of anything else; and when my guide, Mr. Duncan, of Silver Lake, Ore., pointed out the shores of a small alkaline lake that we had reached, after a journey of twenty-eight miles through a trackless desert of sage-brush and sand-hills (from Button's ranch, on the California road), and said, "There is the bone-yard," I requested him and my assistant, George Loosely, of Fort Klamath, Ore., to pitch the camp and get supper, seizing my collecting bag I rushed to the grounds. I found the lake occupied an area of about three acres; its margin was covered with loose sand, and below were the clay strata of the Equus Beds of the Pliocene.

The lake had anciently covered a much larger area, and was gradually drying up. To the northeast, I believe, were large piles of sand that were constantly being drifted away by the action of the prevailing winds. Scattered through the loose sand and on the clay bed were great numbers of teeth and bones of horses, llamas, etc., as well as bones of birds and reptiles, lying loose on the surface—a veritable bone-yard indeed. I was down at once on the ground, picking up bones and teeth and putting them in piles. No two bones seemed to belong together. The skulls and arches had been crushed beneath the feet of animals, probably cattle and deer that had come to drink. What pleased me most was the fact that scattered among these remains were arrow- and spear-heads of polished obsidian. Not a bone

or tooth did I find in its original position, but loose, detached, and scattered, with the implements lying among them in the same way. I was too much excited to think of that fact then.

As Mr. Duncan was to return to the post-office at Silver Lake the next day, starting at daylight, I gathered a cigar box full of the loose teeth, arrow- and spear-points, and packed them to go to the professor by mail. That night, by the light of a sage-brush fire, I wrote the letter he saw fit to publish as soon as he received it. I then honestly thought the implements and bones with which they were mingled were of the same age.

A few weeks later, in search of a new fossil field, I started out among the sand-hills and sage-brush. Rather late in the day I was attracted by seeing the top of a dead spruce sticking out of a high sand-hill. My curiosity was excited, and I climbed to the top of the hill to examine it. It may have been covered with sand for probably a 100 years. I was, however, attracted by a pleasant little valley, scooped out by the wind, on the other side, and, going down to it, found I had stumbled upon the site of an old Indian village. Even the places where their lodges had stood were marked by piles of bleached deer and antelope and other bones of existing species. In front of where each lodge had stood was a large stone mortar and pestle of volcanic rock, probably used by the squaws for grinding acorns and other seeds for making bread. I soon found where an ancient arrow-maker had his shop. Scattered around were great piles of flakes of obsidian, as well as quantities of broken and perfect arrow- and spear-heads, beautifully polished and finished, as well as drills, knives, and the like. Not a sign of anything made of iron could I find. I pulled out from the base of a sand-hill a piece of the back part of a human skull. I also found a spring of cool water that had brought up enough fine sand to build a circular mound five feet above the level of the valley. Doubtless a sand-storm had forced the villagers to flee for their lives, and they were unable to save the mortars. I could not tell how large the village was, as it evidently continued into the sand-hills beyond.

As night was approaching, I gathered up all the lighter implements I could conveniently carry and started for camp. Darkness overtook me before I reached it and I came very near being lost. I gave my pony the rein, and when I concluded I was near camp I shouted to my only companion. At last I was delighted to hear George Loosely's welcome answer; but even then I could not reach it on account of a deaf ear that prevents me from locating sound, and I was obliged to wait until he came to me and guided me back in safety. After this adventure I never again attempted to find the village.

The arrow and other points were the same as those found at Fossil lake, though not so much injured by the weather because longer covered with sand. . . . I concluded, therefore, that the bones of the extinct animals had been covered with sand, protected by sage-brush. It would naturally be a good place for game, on account of the water. The Indians would lose many arrows and spears. A powerful wind, like the one that covered the village, drifted the sand away from over the bones. Arrows, being heavy, would drop down until they became mingled with the bones, and may not have been over a hundred years old.

This experience has taught me caution in accepting the first evidence of ancient man that comes along. Paleontologists wish to add to their reputation by discoveries in the remote past, and it is natural for them to take the first evidence that comes to hand, so they may have the credit if it proves of value. If they are, after all, mistaken they either stick to their first opinion with a determination that seems foolish to an outsider, or back out as gracefully as possible.

Although I have spent many years collecting extinct animals, the arrow-head in the buffalo at Pine creek, Oregon-Washington, is the only evidence I ever found pointing to the great age of man in America. It has always seemed a little remarkable. I suppose that man lived during the time when sand and clay were being deposited in inland lakes. As sand acts as a reservoir for water, grass and other vegetation cover the deposits, thus protecting them from denudation, and the contained fossils are hidden from view. A chance discovery, like that at Lansing, is not likely to be often made; so we may only accumulate the evidence wanted through a long series of years. So it is very important that when a discovery is made it should be substantiated by the great authorities in this line, and be put on record in such a way it cannot be questioned in the years to come, as have, for instance, the Calaveras county man and similar discoveries.

THE PERMIAN LIFE OF TEXAS.

By CHARLES H. STERNBERG, Lawrence, Kan.

Read before the Academy, at Iola, December 31, 1901.

I CONDUCTED an expedition into the valley of the Big Wichita, Baylor county, Texas, for the Paleontological Museum of Munich, Bavaria. I began work on the 14th of June, 1901, and continued four months. I was employed by the famous Doctor von Zittel, the early teacher of the deceased Cope and many other noted American paleontologists. It was pleasant to receive these words of praise from such a noble source: "Your collections from Kansas and Texas in the Munich Museum will always be, as I wrote you, an everlasting memorial to the name of Charles Sternberg." I labored this season, assisted by my son George, under trying conditions, the heat often running the mercury up to 113° in the shade, and, when reflected from the brilliantly colored rocks, it was very severe on the eyes. The whole Wichita valley this year is almost a desert. The few cattle, scattered over thousands of acres, are poorer than I have seen them in midwinter during former years. There are no wells or springs in the Red Beds. Spasmodic showers are partly retained in natural or artificial tanks. I had to haul my camp water from six to eighteen miles, as well as hay and grain for my team. By constant effort, under the difficulties that beset me, I was able to add twenty distinct forms to the Permian fauna of the Munich Museum and to science. They will be carefully studied and described.

No work, I believe, has been done on these remote ancestors of living animals since Cope died, except in Munich, where, in 1899, Doctor Broili, Doctor von Zittel's assistant, wrote a valuable paper on Cope's great salamander, *Eryops megacephalus*, as the result of his study of the material I collected for them in 1895. Last August, Doctor Broili came from Bavaria to visit my camp, and spent two weeks with me in the field, taking photographs and notes of the formation. He was delighted with the results of my work, assuring me that the collection had far greater scientific value than the one I made their museum in 1895. I think quite a number of new species are present, as well as many described by Professor Cope. One, his *Diplocaulus magnicornis*, was quite common in certain localities.

I found in the roots of the grass, and along a slide, ten casts of skulls I thought worth saving, with fragments of many others scattered around. Every particle of bone had disappeared. I got several better specimens than the type. The vertebral column and limbs

were present in several specimens. I suppose this unique amphibian was an ancient frog. The skull is very much compressed vertically; the mandibles are usually locked together with the maxillæ; at the chin the jaws are only about half an inch thick, while the horns are an inch and a half. I found several skulls that measured over a foot from the end of the premaxilla to the distal point of the horns. The whole skull appears as a comical imitation of the man in the moon when he is half full. The very beautiful sculpture on all the outer bones of the skull is remarkable. The vertebræ have twin spines on each side of the centra. I think, when alive, this frog must have been six feet long. In another species I discovered, of the same genus, the skull was much narrower behind. It was beautifully cleaned by long erosion, and so perfectly preserved that it was not difficult to believe it was a recent specimen.

As a rule, all the fossils of this region are covered with a thin siliceous matrix that is difficult to remove; when exposed to the weather for a long time this is sometimes worn off. This region was the home of Cope's great salamander, *Eryops megacephalus*, which ought to mean flat-headed. When we compare our living American salamanders, that rarely exceed eight inches, with this grandfather of all the mud puppies, we are struck with the enormous proportions reached by *Eryops* during the Permian. I found an absolutely perfect skull this year that was about twenty inches long, including the bones that support the tongue. It is covered with a thin, red, siliceous matrix, which I hope can be removed. All the outer bones of the skull are beautifully sculptured. The bones that support the broad, flat quadrate are projected well back of the base of the skull. The lower jaws extend still further back and are more powerful than those of an ox. A single row of large and small teeth, conical in shape, occupy the jaws, while the palatines carry six sets of two powerful teeth each, placed closely together, three sets on each side of the roof of the mouth. The skull is vertically compressed, but, unlike *Diplocaulus*, the eyes are placed well back in the face. The occipital condyles are shallow, saucer-like pits. The creature was about ten feet long.

I found a nearly complete skeleton of this huge animal for Professor Cope in 1896, under peculiar circumstances. It lay at right angles to a large cattle trail over which thousands of Texas cattle had made their weary pilgrimage to Kansas and the North, and the constant wear of countless feet had worn off the flint-like matrix and exposed the completely petrified bones, while on the ridges they were not exposed at all, except in cross-section caused by breaks in the rock. The vertebræ are of lowly type. The centrum is composed of three distinct bones, the central or *plurocentrum*, and the two lateral ones or *hypo-*

centra. The dorsal spine with its processes attached are in one piece.

That same year (1896) I was so fortunate as to find a batrachian with a carapace—one of those discoveries of a lifetime that connects great orders. Professor Cope believed this to be the parent stem from which the family of turtles sprang at a later stage in the history of life.

My son and myself discovered three bone-beds full of minute forms, several of which are, I believe, new in science. I look forward with great interest to their description by the Munich Museum. They range in size from less than a quarter of an inch to over an inch in length. I collected over twenty skulls, and many more or less perfect. Quite a number had vertebræ attached. I collected thousands of bones from all parts of the the skeletons. In one case a complete skull one-fourth of an inch in length had connected with it nearly the complete column with ribs attached, coiled upon itself, and bedded with many bones of other species in a red, siliceous matrix. So perfectly were they weathered out, that they lay in bas-relief as white as snow, and as perfect as if it died a month ago. A single row of minute teeth, like the points of cambric needles, filled the jaws. It seemed to me that this little fellow, not over six inches in length, must have made a snug bed in the mud and lay down to hibernate, but never wakened; millions of years later I found him ready to do his share, by adding one more fact to human knowledge—one more link to the endless chain of life that nature has produced so abundantly on this old world of ours. I dare not even guess at the family to which it belongs. The bones of the skull are perfectly preserved, quite smooth, and show the sutures distinctly; there is no distortion. Some red rock attached below seems absolutely necessary to convince the mind it is not a thing of yesterday.

Another, broad and flat, a little like *Diplocaulus*, with eyes well forward. It is an inch in length, with delicate tracery upon the bones, single rows of minute teeth in the jaws. Some were compressed laterally, the delicate little quadrates connecting the mandibles with the skull at an angle of forty-five degrees. In this form the orbits are placed well back in the face. Another extremely beautiful skull had the bones marked by small dentations and elevations; was much compressed vertically; there were small teeth in the front part of the mouth only.

I should not neglect, in this connection, the enormous *Dimetrodon* of Cope, a reptile of large proportions and huge dorsal spines. Some of these spines were over three feet long, with a pair of lateral spines at the base, which then alternate to the apex, smooth and conical in

Iola Portland Cement Mill, 1900.

shape, slightly recurved, with round, indented knobs at the ends. The first pair are about three inches long, and gradually decrease in size as they ascend. I call this animal "the ladder-spined reptile." I am told that Professor Cope believed these spines served as masts and yard-arms, from which were stretched membranous sails which enabled them to catch the breeze and tack along the surface of the ocean. Possibly, as the vertebræ are small and the spines extremely slender, these lateral processes gave stability, when securely bound by strong ligaments to the flesh on the column, preventing dislocation. I have found many fine specimens of this remarkable reptile. One found this year represented parts of the upper jaws. A huge, massive bone projects beyond and below the huge tusks in the lower jaws, bent in a curve, presenting a unique appearance, for what purpose I can hardly guess, unless to give rest to the head while sleeping. But time would fail me to tell even in this cursory manner of all the strange life preserved for us of these ancient mariners who lived in the water or along the swampy shores of the Permian ocean. How those ancient frogs must have tortured the ear of night on a warm summer evening!

I must now turn a short time to the rock formations, of which there are two distinct ones in the valley of the Big Wichita, in Texas, which give characters to the surface of the country, as different from each other as if separated by hundreds of miles. I visited one locality on Pony creek where the Red Beds lie on top of the Gray Beds conformably. Looking to the west, a vast panorama of crumbling and denuded bluffs, narrow valleys, beetling crags, desolate and forlorn, with the universal red color dominating everything, except here and there relieved by the green of stunted mesquites or patches of verdure, was spread out before me. To the east lay the narrow valley of Pony creek, with the same topography so familiar to the residents of eastern Kansas—a ledge of gray sandstone, forming a narrow escarpment on either side, and following the trend of the hills around the ravines; grass coming down in gentle swells to meet it, or running up from the bottom lands below. The greatest thickness of this sandstone, as I observed it, was near my camp in the creek bottom where I had pitched it, eight miles north of Seymour, the county-seat of Baylor county. This was at the head of a narrow gulch that had cut through it. I made a section and sent samples of the rock to Munich. As I observed it under peculiar circumstances, it solved another interesting problem—the water-supply of the Red Beds. I discovered why the water that falls where these beds are only exposed runs off soon after a shower, except when caught in natural or artificial tanks. No wells

or springs are ever found. In the Gray Beds, however, there are always springs and streams of running water.

In September, 1901, the heaviest rain since May fell in torrents for an hour and a half. Water lay everywhere on the surface of the ground, but soon disappeared. My son had discovered a locality rich in fossil invertebrates, consisting chiefly of casts of coiled and straight, nautilus-like shells, across the creek, and shortly after the downpour I went over there to my work, but had not been engaged long before George shouted to me that if I did not want to swim I had better cross. His advice I followed so hastily that I left my tools behind. Instantly a raging, boiling flood of water covered the rocks in the bed of the creek over which I had just crossed dry shod, rapidly rose to eight feet, and threatened to submerge my camp. Looking for good ground on my side of the creek (the west), I found the gulch before referred to. There was first a level floor, formed by the first stratum of the Gray Beds, extending west 500 yards to a ledge of red sandstone eight feet thick, the floor covered with the debris washed from the Red Beds. To my astonishment, although the surface was dry, a flood of water was rushing out from under the upper deposits, and tumbling in a minature waterfall over the gray ledge (nearly five feet thick) into the ravine below. The upper sandstone layer is composed of very fine-grained sand that seems to have been ground into an impalpable powder by the beating of the waves. It is very compact and heavy, breaking on exposure into rectangular blocks so perfect in shape that they can be used for building purposes without the use of the hammer and chisel. This stratum is eight inches thick, and is free from fossils. I believe it contains some lime. The second stratum breaks into large blocks of many tons weight, contains a few casts of invertebrate fossils, is coarser grained than No. 1, and about twenty inches thick. No. 3 is of the same general character as the other layers, twelve inches thick, and literally packed full of the casts of straight and coiled shells related to our living nautilus, and they are mingled in great confusion. I believe some of the coiled shells were a foot in diameter. This stratum is not as compact as the others, and seems to contain more lime. No. 4 is a very solid gray sandstone, eight inches thick, its upper surface crossed at various angles by elevated rounded ridges of harder material than the rest.

From these observations, I conclude that the pervious nature of the Red Beds, which in the valley of the Big Wichita are about 300 feet thick, allows the water that falls upon them to rapidly percolate through until it reaches the impenetrable gray sandstone; then it runs off at whatever angle the rock may be tilted.

GEOLOGY OF LYON COUNTY, KANSAS.*

By ALVA J. SMITH, Emporia, Kan.

Read before the Academy, at McPherson, December, 1899.

THE section begins with a stratum of coal from fourteen to eighteen inches in thickness on the east line of Lyon county, two miles east and one mile south of Neosho Rapids, where the formation has a dip of about twenty feet to the mile nearly west. Elevation, 1000 feet.

Above the coal is found from six inches to two feet of shale, then an eighteen-inch limestone, eighteen inches of shale, and another limestone of about equal thickness. The limestones referred to are also well exposed in the river at the Neosho Rapids bridge. Thence passing northwest over about forty feet of shale, we find a limestone thirty to forty feet thick. This stone is characterized by rough weathering, many cavities filled with calcite crystals, a conglomerate appearance, and clusters of *Fusulina cylindrica*. On account of its proximity to Neosho Rapids, it has been designated the Neosho limestone until it may be identified as a stone previously named elsewhere. A good exposure of this stone is found in Rock cut three-quarters of a mile west of Neosho Rapids. It is also well exposed in the ravines to the north and northeast, and is also found forty feet thick in a well at the foot of Chicago mound, five miles southwest of this locality.

Above this stone is twenty-two feet of arenaceous shale approximating sandstone in places, then a two-foot limestone containing concretionary nodules averaging two inches in diameter. These nodules are mostly constituted of oxide of iron, but some are found which carry a small quantity of zinc sulphide. This stone is well exposed in Chicago mound and the ravines north of Neosho Rapids, in Badger creek, north side section 11, township 19, range 12, and Coal creek. Two feet beneath this stone is a stratum of coal six inches thick, which I take to be a remnant of the Osage City coal.

Between this and the Burlingame limestone is thirty feet of shale and sandstone. The Burlingame limestone is well exposed at Humphrey's ford, six miles southeast of Emporia, where it has a dip of eighteen feet to the mile, 70° west of north, and passes under the river about two miles farther up.

Passing up the bluff seventy-five feet, at Humphrey's ford we find, above the Burlingame limestone, nine feet of yellow and blue shale,

*Map and sections illustrating this article will be found in volume XVII of the Academy's Transactions.

one foot of limestone, fourteen feet of shale, seven feet friable limestone, which is overlaid in places with a mass of excellently preserved specimens of *Streptorhynchus crenistria*, 13½ feet of blue and yellow shale, calcareous in places, three feet hard blue limestone, with a seam six inches from the top. This stone I have designated the Emporia blue. The six-inch top layer makes a good quality of flagstone, which is extensively used in Emporia. Above this is four feet of slaty shale and another hard blue limestone, agreeing paleontologically and lithologically with the one below.

These stones, with a dip of sixty-five feet in four miles, pass under the Cottonwood river at Soden's mill, one mile south of Emporia, and are found in wells forty feet below the surface in the city; also in the Neosho river, at Rinker's bridge, three miles northeast, and are extensively quarried in section 14, township 20, range 12, and sections 6, 9, 30, and 31, in township 19, range 12, and section 12, township 19, range 11, and near Olpe, Reading, and Salt creek.

Above these stones is ten feet of shale, a twelve-inch limestone, eight feet more shale, and a five-inch coal stratum, which is exposed in the banks of Dry creek, three miles south of Emporia, and on Coal creek, a few miles farther south, where it is three inches thicker, and has been stripped for local consumption. The forty feet of shale which overlays the coal is quite variable in character, being carbonaceous in places; in others, sandy, calcareous, or argillaceous. A very productive horizon of fossil flora lies near the top of this bed. In the sandy portions good examples of drift bedding are often exposed. A five-foot sandstone near the top is separated from the Emporia system by five feet of buff shale. Overlying this, on the north side of the river, is the Emporia system of limestones, composed of five members from one to two feet in thickness, with intervening shale beds from four to ten feet thick. This system is best exposed in the ravines and hillsides sloping to the Neosho river just northwest of Emporia, where, in some places, they have a local dip to the north of fifty feet to the mile.

South of the Cottonwood river the character of this system is very different, being mainly a mass of fragmentary limestone five to eight feet thick, with the crevices filled with clay. A good exposure of this condition is found in the southeast quarter of section 29, township 19, range 11.

Above the Emporia system is twenty-seven feet of sandy shale and sandstone with *Myalina subquadrata* near the top; then an eighteen-inch siliceous limestone streaked with red, containing *Pinna peracuta;* then another sandy shale bed forty-seven feet thick, which is overlaid with ten inches of coal.

This coal is exposed eight miles southwest of Madison, in Greenwood county, and in Lyon county on the Verdigris river, section 34, township 21, range 10; on Shaw creek, Rock creek, and Moon creek, in the southwest part of the county; near Phenis mound in section 1, township 20, range 10; in Reservoir hill, near Emporia, near the center of section 30, township 18, range 11; on Stillman creek, seven miles north of Emporia, in section 4, township 18, range 12; in the northeast corner of section 30, and west side of 33, township 17, range 12; two miles east of Admire, on One Hundred and Forty-two creek; and on Elm creek, in section 33, township 15, range 12. The thickness of this coal varies but little in the entire distance that I have traced it. It has been stripped for local trade in a number of places. It burns well, but contains an excessive amount of ash—amounting to over twenty per cent. The dumps where this coal is stripped always contain many *Myalina subquadrata*. The shales near this coal yield small quantities of oil and gas in at least ten places in the county. Overlying the coal is ten feet of sandy shale, one foot limestone containing *Myalina subquadrata*, eleven feet of sandy shale and sandstone containing ripple-marks, eighteen inches limestone, fifteen feet shale, two feet limestone, fourteen feet shale, five feet calcareous shale, seven feet shale with cone-in-cone structure, ten inches limestone, ten feet shale with thin coal seam, two feet limestone, and forty-five feet of shale containing red sandstone in places, which brings us to the Americus system, consisting of one foot limestone which weathers to *dry-bone* formation, eight feet shale, twenty-one inches good building stone, containing many *Fusulina* of the robust type, six feet shale, and a six-inch flag limestone. The shale on either side of this stone contains an abundance of *Fusulina*. The twenty-one-inch stone of this system, known as the Americus limestone, is extensively quarried in the top of the hills south of Americus, and near Allen. The top of Phenis mound, ten miles southwest of Emporia, altitude 1278 feet, is a few feet lower than the Americus stone, which may be seen in the hills to the southwest.

Above this is from eight to twenty-six feet of black, blue and buff shale containing *Retzia mormoni*, *Rhynconella* sp.? and many crinoid plates and stems, two feet blue limestone containing *Fusulina cylindrica* and *Productus semireticulatus*, four feet calcareous shale, eighteen inches *Fusulina* limestone, four feet shale, one foot limestone containing *Myalina subquadrata* and *Archæocidaris* spines, ten feet nine inches shale, to a friable *Fusulina* limestone eight feet thick, embracing a twelve-inch shale stratum. This stone is exposed in the bluff at Elmdale mills, Chase county, and is level with the bridge spanning the river at that place, thirty feet above the water. In the

bluff south of Saffordville it is sixty feet above the river. Good exposures are found at Allen and many other places in the county. It is one of the easiest formations to trace, on account of the soil being strewn with countless numbers of *Fusulina cylindrica* of the robust type for some distance below the outcropping margin. The top four feet of this stone is heavy bedded and contains crinoid stems and *Polyzoa*, but fewer *Fusulina*. Above this stone is ten feet of buff shale, one foot of limestone, six feet of blue shale, six feet of buff shale, six feet of heavy bedded limestone with *Archæocidaris* spines, five feet of shale, eight inches of shelly limestone, thirteen feet seven inches blue and yellow shale, three feet of limestone, six feet four inches of buff shale, six inches of limestone, three feet eight inches of shale, four feet of thin bedded limestone, parts of it having a porcelain appearance (this appearance is characteristic and has been observed in many places in both counties), four feet two inches buff shale, eighteen inches limestone, six feet two inches blue and yellow shale, twelve feet limestone which weathers very rough, eighteen feet or more of shale, to the Cottonwood Falls stone. This line is the top of Prosser's Wabaunsee formation.

The Cottonwood formation embraces the Cottonwood Falls stone, six feet six inches thick, and the twelve-foot fossiliferous shale bed above it. The Neosho formation overlying the Cottonwood is well exposed in Crusher hill, one and one-half miles west of Strong City, and has been so well described by Prosser and others that a detailed description need not be given here. No. 2 gives a reasonably accurate section of the hill, which is capped by a flinty limestone from twenty to forty feet thick, which corresponds with the lower flint beds of Hay's Fort Riley section. The dip carries this stone beneath the river valley at Cedar Point, where section No. 1 was obtained, at a bluff three miles northwest of the station. The top of section No. 1 is 1330 feet above sea-level.

From the east line of Lyon county to Emporia the westward dip averages fourteen and a half feet to the mile; from Emporia to Saffordville, nearly twenty feet to the mile; from Saffordville to Strong City, twelve feet to the mile. Strong City is nearly in the trough of a syncline where the Cottonwood Falls stone is level with the railroad-track. Passing west from Strong City, an extensive anticline amounting to over 120 feet is observed, the axis of which is near Elmdale, and apparently trends fifteen or twenty degrees west of north into Morris county and south toward the Flint Hills. Local dips amounting to two or three degrees are frequently found in this area. From a mile or two west of Elmdale to near Clements the usual westward dip is again maintained, while at and west of Clements the dip becomes ex-

cessive, amounting to fifty feet per mile, which brings the lower flint beds to the river valley at Cedar Point.

At Saffordville, the Americus stone is a few feet above the water in the river and the Cottonwood Falls stone is in the top of the hills beyond the bluff. A better exposure of nearly the same strata is found at Elmdale mills, fifteen miles farther west, where section No. 3 was obtained. The Americus stone is under the river at this place.

While considerable attention has been given to the paleontology of the district, my collection of fossils is too incomplete and too many are unidentified to warrant publication at this time, and such reference as I have made to fossils has been done only when they appeared to be especially characteristic of the formation and might aid in its identification.

FURTHER STUDIES IN THE MENTOR BEDS.

By ALFRED W. JONES, Kansas Wesleyan University, Salina.

Read before the Academy, at Topeka, January 1, 1903.

MY only apology for sticking to this subject is that my geological field-work has been limited to the counties of Saline, Lincoln, Ellsworth and McPherson during the past two years, and the fact that the Mentor Beds are not receiving much attention from other geologists.

The Dakota and its associations in Kansas afford a most fascinating field for investigation, and demand a thorough and careful study before many tangles can be unraveled.

Although I am not prepared to attempt any plan of division, I am inclined to believe that a very careful study of the Dakota would separate it into different leaf-bearing beds of different groups of plants interspersed with thin, shell-bearing layers.

The division line between Comanche and Dakota appears to be less distinctly marked as more light is thrown upon it. Three or four years ago I thought I was quite certain regarding some features of the Mentor; to-day, after much more investigation, I know much less about it. However, I am still inclined to believe that the "Mentor" proper lies at the base of the Dakota: that when thoroughly traced it will reveal to us the outlines of an ancient gulf, with several of the inlets marked by fossil beds containing only fresh- or brackish-water species.

I have now located three of these localities—one four miles north of Salina, in the Claflin pasture; one north of Brookville, on Mulberry creek; one about six miles northeast of Kanopolis, Ellsworth county, on the Smoky Hill river.

The Marquette region, southwest of Marquette, reveals a puzzling condition—in the bottoms of ravines we find Permian shales; resting upon this the calcareous shales of the Kiowa; then apparently typical Dakota sandstone bearing fossil leaves; and above this a heavy ledge of sandstone containing an abundance of Mentor fossils.

Although I have not had the opportunity of exploring very far southwest, I am informed that shell-bearing rocks outcrop at many places in western McPherson and eastern Rice counties that I did not visit.

Several more cases have been reported to me of shell-bearing strata having been found near the base of the Dakota in well-digging, and a few more surface exposures have been found in Saline county.

The shell beds near the top of the Dakota, in Ellsworth county, containing *Modiola pooli*, contain a small univalve that has not been determined.

With so much for the Mentor, I will add a note or two on the Dakota.

Professor Mudge, in writing of the Dakota, in the First Biennial Report of the State Board of Agriculture, said (after speaking of the irregular distribution of fossil-leaf beds): "The numerous indications show that the trees must have grown on islands near the shore-line, and that the leaves were embedded in the marine sediment immediately after dropping. Worm borings are also found in the same strata with the leaves."

Now, although this observation is probably in the main correct, I have been astonished again and again to find how widely distributed fossil vegetation is throughout the sandstones of the Dakota in this region. Several times I have been shown very good specimens of fossil leaves quarried or revealed in breaking rocks in localities that I had looked over and passed as utterly destitute of fossils; and I have learned by experience that diligent search will find traces of fossil vegetation almost anywhere in the Dakota, which seems to me to indicate that the ancient forests of the Dakota probably covered much more of the surface than I had at first supposed, but that conditions were much more favorable for preserving fossils in some localities than in others.

Reports have come to me several times, from sources that I can scarcely doubt, of the finding of fine leaf impressions in the clay beds of the Dakota revealed in cellar- or well-digging, and I regret that as yet I have been unable to see any specimens of these.

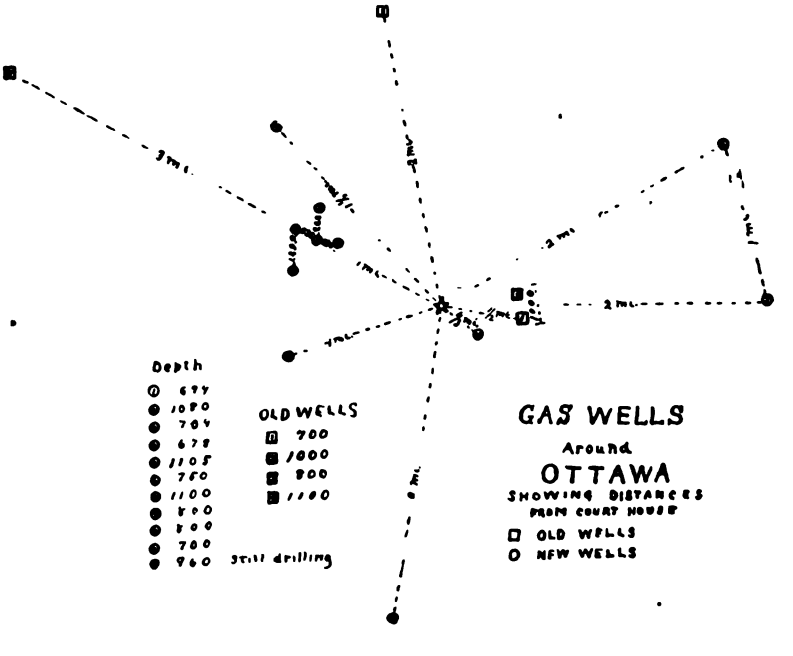
THE OTTAWA GAS-WELLS.

By J. A. YATES, Ottawa University, Ottawa, Kan.

Read before the Academy, at Iola, December 31, 1901.

IN the year 1887 a company was organized in Ottawa for the purpose of prospecting for gas, oil, or anything of value beneath the soil. I. N. Boycourt was elected president. Four wells were drilled, as shown on the map. In Nos. 1 and 3 gas was found in considerable quantity; but having inexperienced workmen employed, and also being a prospect, the gas-sand was reached before the well was properly cased, and it filled with salt water. From well No. 3 bubbles of gas have continued to escape to the present time. The amount of gas found was considered too small for piping, the prospect was considered a failure, and the company decided to abandon the work.

In the year 1898 a company was organized for the same purpose as the former company, with Mr. H. L. T. Skinner president, who, with his characteristic enery and ability, has kept the drill going almost ever since, and they are at present drilling the eleventh well. The log of well No. 2 is given and also the partial log of well No. 11. The elevation of our court-house above the sea-level is about 700 feet. The average depth of all the wells is about 720 feet below the eleva-



tion—that is, twenty feet below sea-level, when the topography of the county is considered.

Gas and other products have been found in the wells as shown in the table. The company, hoping to strike a stronger flow of gas than that found in any of the wells, has continued to pull the casing and hunt for "a great gusher." A well yielding 50,000 cubic feet per day is generally considered worth casing and piping. A reference to the table will show that some of the wells reached that amount.

No. 1 in the new series was also a prospect well, the company not having access to the log of the former wells. The gas-sand was reached without properly casing out the salt water, and consequently the well had to be abandoned. The drill used is the ordinary churn drill, and the measurements made on the rope with a steel tape. The logs of the different wells show only slight variations in stratigraphy when the topographical differences are considered. Gas continues to bubble from some of the larger wells. The amount of gas as shown in the table was estimated from measurements made with an ordinary gas-meter.

No. of well.	Depth of well.	Depth gas-sands.	Thickness of gas-sands.	Estimated flow of gas.	Oil.	Depth of salt.
1	674	423 664.5	52 57	5,000 50,000	....	323 628
2	1,080	425 665 803 1,080	50 58 27 15	12,000 25,000 Very little. "	665, some oil.	323 ..... 628 1,080
3	704	424 666	50 60	Very little. "	666, 3 barrels per day.	
4	678.5	424 665	35 13.5	No gas. 10,000	665, 2 gallons, very black and heavy.	
5	1,105	420 672 802 1,060 1,105	9 40 10 12 Salt water	No gas. 50,000 No gas. " stopped work.	Coal, Seam 1 foot thick at 690— semi-anthracite.	
6 7 8 9 10 11	750 1,100 800 800 700 *960	No gas worth piping.				

*Still drilling.

LOG OF WELL No. 2.

Formation.	Top.	Bottom.	Formation.	Top.	Bottom.
	ft.	ft.		ft.	ft.
Soil	5	5	White slate	5	598
Limestone	12	17	Limestone	16	614
Slate	5	22	Slate	8	622
Limestone	43	65	Limestone	18	640
White slate	146	211	Slate and shells	15	655
Limestone	21	232	White slate	10	665
Slate	20	252	Gas-sand*	58	723
Limestone	6	258	Slate and sand	12	735
Slate	60	318	Black slate	20	755
Limestone	27	345	White slate†	48	803
Shale	5	350	Sand	15	818
Limestone	31	381	Slate and shells	27	845
Shale	3	384	Sand	8	853
Limestone and shells	15	399	Slate and shells	82	935
White slate	37	436	Sand	10	945
Gas-sand	54	490	Slate	10	955
Slate	25	515	Sand	37	992
Sandy slate	53	568	Black slate	78	1,070
Limestone	15	583	Salt and water	10	1,080
Black slate	10	593			

*Good gas-sand from 670 to 680 feet; water at 715 feet. †Water.

PHYSIOGRAPHIC DIVISIONS OF KANSAS.

By GEORGE I. ADAMS, Washington, D. C.

Read before the Academy, at Iola, December 31, 1901.

THE eastern portion of Kansas has only a moderate elevation above sea-level, the river valleys being about 750 feet above tide where they cross the boundary. The surface rises to a height of about 4000 feet in the northeast corner of the state, but the transition is gradual, and mountainous features nowhere occur Isolated mounds, hills, ridges and escarpments are the boldest forms of relief, and are conspicuous in contrast with the broader stretches of gentle slopes, rolling prairies, terraced uplands, broad plains, and moderate stream valleys. While the topography of Kansas is that of a plains country, it presents an ever-pleasing variation to the traveler, or impresses him anew with its quiet grandeur. The text-book of geology is here so plain that he who runs may read in simple lessons the story of the formation of the earth and the manner in which it has been sculptured into pleasing features. There are no overpowering scenes, and, although there are broad problems, the mind is seldom perplexed when considering that which lies within the range of vision. It may be that this is the reason that the general features of the state have thus far not been outlined. There are many fine descriptions of impressive localities and isolated scenes, but no one has attempted to distinguish the units which constitute the physiographic divisions of the state. Most of them are already well described, but their limits have not been defined or shown on a map. It is the purpose of this paper to indicate as clearly as possible their boundaries and salient characteristics, and to supplement brief descriptions by quotations from the already voluminous literature.

The first general physiographic map of the United States published was that by J. W. Powell, in the National Geographic Monographs. The limits of the regions are there not closely defined, and subsequent study has shown the necessity of modifying them somewhat. The map of the physical divisions of the United States contained in Davis's Physical Geography differs from that of Powell in certain details, but it likewise is subject to revision. In the accompanying sketch map the results of a closer study of the regions adjacent to Kansas are presented. It is incomplete in part, especially in failing to show the limits of the regions in the southern portion of Oklahoma. It, however, presents clearly the physiographic relations

Sketch showing physiographic relations of Kansas, by George I. Adams.

of Kansas, the features of which it is the purpose of this paper to discuss.

The state of Kansas, with the exception of the extreme southeast corner, which is a portion of the Ozark region, lies within the Prairie Plains and the Great Plains regions. These divisions are characterized by their broader physical aspects and their simple geologic structure. They are not clearly defined by topographic differences, although they have a general unity of surface features and altitudes.

THE OZARK REGION.

The country here designated as the Ozark region has been discussed from various standpoints. In the following definition, it is considered as structurally related to the Arkansas valley and the Ouachita mountains:

> Broadly defined, the Ozark region embraces the southern half of the state of Missouri, a very small corner of southeastern Kansas, the northeastern part of Indian Territory, and the northern part of Arkansas. . . . In a general way the Mississippi and Missouri rivers bound it on the northeast and north, Spring, Grand and Arkansas rivers approximately limit it on the west and south, while the upper portions of the St. Francis and Black rivers mark its southeastern margin. . . . In its northern portion it is to a large extent a rolling plain, and in its southern and more rugged part the broken character is evidently the result of erosion by streams which have deeply dissected a generally even sur-

face. . . . As compared with the Mississippi valley, the region is an elevated one. To the north and west of it lie the Prairie plains; to the east and southeast are the Gulf plains. . . . The structure of the Ozark region is simple. The Boston mountains, on its southern border, are of a monoclinal type, while the plateau portion, or northern part, has the form of a low dome, with local faulting and minor undulations. To the south of the Ozark region is the Arkansas Valley region, which has a folded structure, and beyond it the Ouachita Mountain region, which is closely folded and thrust-faulted. . . . In the southern portion of the Ozark region are the Boston mountains, which are a dissected highland extending through northern Arkansas, from Batesville to near Wagoner, in Indian Territory. The northern portion of the region is the Ozark plateau, which consists of two divisions. The eastern one is the Salem upland and the western the Springfield upland. They are separated by the Burlington escarpment. (Adams, Physiography of the Ozark Region, 22d An. Rep. U. S. Geol. Surv., pt. II, pp. 69–75.)

In the extreme southeast corner of the state there is a small portion of the Springfield upland. Its general surface is a structural plain developed on the Mississippian limestone. The plain is limited on the west by the valley of Spring river, which is located approximately along the contact of the Coal Measure shales. The portion in Kansas is the border of a westward-dipping structural plain, and, lying adjacent to the Cherokee lowland, is considerably reduced, and has but a slightly greater altitude. The country rock of the Springfield upland contains much flint. Its surface is accordingly in strong contrast with the lowlands to the west, which are developed on soft shales and sandstones. The limestones, which constitute the upland, contain valuable deposits of lead and zinc. The principal town of the area is Galena.

PRAIRIE PLAINS REGION.

The Prairie Plains region embraces that portion of the Mississippi valley which lies at a moderate elevation, and in which the processes of reduction have brought the surface of the country to a generally level plain. Its surface features have been developed by erosion, and mountainous structures are nowhere present. The changes of level which the Prairie plains have undergone were relatively slight as compared with the mountainous regions which have been the centers of the disturbances. To the northeast of the Prairie plains are the Lake plains, which are related in their development to the Great Lakes. To the south of the Prairie plains are the Gulf plains, which have been developed as a result of the oscillations of the Gulf of Mexico. To the east and west the Prairie plains pass by easy gradations into higher altitudes and into higher plains or plateaux, which are adjacent to the Appalachian region and the Rocky Mountain region. It will thus be seen that the Prairie plains occupy an intermediate position in the Mississippi valley. Their physiographic history is related to that of the regions on the north, east, south, and west.

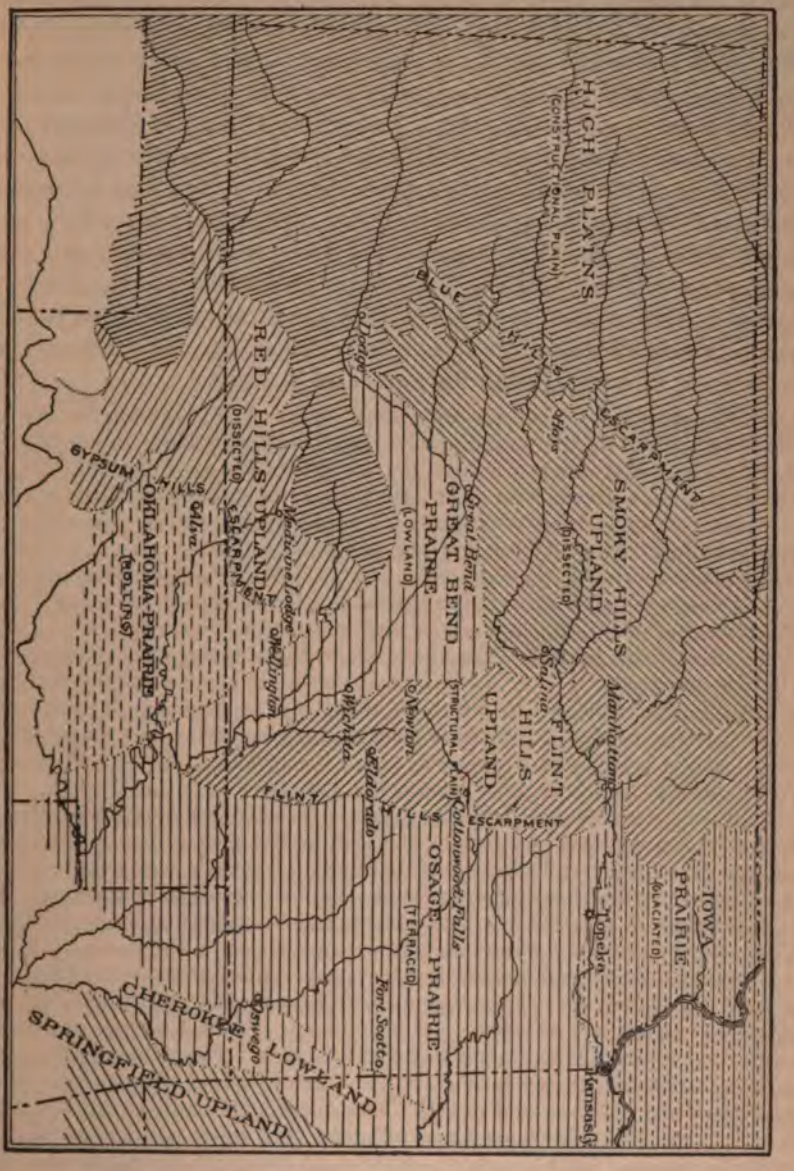
Lying near their center, in southern Missouri, eastern Arkansas, and the Indian Territory, is an area which has a mountainous structure. As a result of continuous erosion by streams since the establishment of the drainage system of the Mississippi valley, the Prairie plains encroach upon its flanks. Another factor in the development of the Prairie plains was the advance and retreat of the ice sheet which covered their northern portions in glacial times, sculptured the surface, and left behind upon its retreat vast accumulations of rock material. This portion of the Prairie plains is known as the glaciated, in contrast to the southern, or non-glaciated, division of the region.

To the west of the small area of the Springfield plain in the southeastern corner of the state there is a belt of low-lying country known as the Cherokee lowland. This area continues in Missouri, and has there been called the Nevada lowland; it also extends into Indian Territory along the valley of the Neosho or Grand river, where it merges with the lowland plain of the Arkansas Valley region. The lowland is developed on the soft shales and sandstones which form the base of the Coal Measures in Kansas. The shales have a thickness of about 450 feet, and are exposed over a belt of country approximately twenty-five miles wide, within which are situated Cherokee county and portions of Crawford and Labette. In Missouri the area tapers to a point, as a result of the overlapping of the higher beds which form its western border onto the rocks of the Springfield plain.

The surface is gently undulating, the monotony of lowland topography being occasionly broken by ridges and mounds which occur on the divides and owe their existence to heavy sandstones. Such a mound is the one west of Baxter Springs, near the territorial line. The country around Columbus exhibits a number of sandstone ridges, the city being located upon the divide between Spring river and the Neosho. . . . The western border of the Cherokee uplands is the Oswego escarpment, which is produced by the first important limestones in the Kansas section of the Coal Measures. This formation is known as the Fort Scott limestone, and at Oswego caps a bed of shales, producing an escarpment which along the river bluff is 120 feet high. (Adams, Physiography of Southeastern Kansas, Kan. Acad. Sci., vol. XVI, p. 57.)

The surface of the lowland is gently undulating, with watercourses flowing in wide, flat-bottomed valleys bordered by low, gentle slopes. Toward the western side of the valley outliers of the escarpment bordering the northwestern side relieve the general monotony of the landscape. The whole area is practically down to grade. It is already a lowland of denudation. It has long since passed through its stage of most pronounced relief and is now gradually wiping out the varieties of its surface. On the softer rocks, in the vicinity of Clinton, the general level is in many places less that fifty feet above the level of the flood plains of the streams. . . . The area of the soft beds has been exposed to degradation no longer than that of the hard limestones comprising the Springfield structural plain, yet the soft ones have reached old age in the cycle, while the harder ones are in a vigorous youth. (Marbut, Mo. Geol. Surv., vol. X, p. 67.)

Roaring Spring Cliff, Ellsworth county, Kansas. Showing Escarpment of Dakota Sandstone Left through erosion.



Map showing physiographic divisions of Kansas, by George I. Adams.

The Iowa prairies, that portion of the division of the Prairie plains which lies in the northeast corner of Kansas, owes its peculiar surface features to the fact that the rock formations are covered with a mantle of drift, deposited during the glacial period. The southern border of the glaciated area is a line approximately along the Kansas river in Kansas, and from the mouth of that stream along the Missouri river in Missouri. Since the deposition of the drift the streams have cut their channels deep enough to expose the underlying rock formations and revive in modified form the original topographic features. As a result, there are in places fragments of terraces and escarpments similar to those which prevail in the Prairie plains south of the glaciated portions. No attempt is made to define the limits of the Iowa prairies beyond the boundary of the state. They extend into Missouri, and find their larger development to the northeast in Iowa.

Northeastern Kansas is the southwestern corner of Iceland—that is, it is the southwestern part of the area which, in the times immediately succeeding the Tertiary age, was covered with ice. . . . Where the ice halted and its terminus remained stationary for a time, the melting being exactly met by the supply from the north, there was formed a terminal moraine as a result of the accumulation of the solid matters it had carried along with it. . . . The true hard-pan or till is a stiff, pasty, dark-brown clay, with pebbles and small boulders. It seems to have been formed under the ice by the grinding of the material over which the glacier passed—clay shales, soft limestones, and sands. . . . The loess is often called bluff, because the bluffs of the Missouri river are formed of it or capped with it. . . . Over immense areas it is substantially the same material as that which gives color and muddiness to the water of the present river. In some regions it takes color from local surroundings, and has streaks of coarse sand or gravel, and becomes of orange brightness. (Hay, 8th Bien. Rep. Kan. St. Bd. of Agri., vol. XIII, part II, pp. 118, 119.)

Boulders lie scattered in small numbers in detached areas, north of the Kansas river, from the Missouri nearly to the Republican, but west of the latter none are noticed. The drift gravel extends a little farther. The origin of our drift, like all others in the northern hemisphere, must be sought in regions far to the north. No original ledges of quartzite or other metamorphic or igneous rock are found within 300 miles of the northern state line, and it is only in the western portions of Minnesota that these deposits are represented. No other material of our drift is found so near. . . . The larger stones attain the size of true boulders, being sometimes ten feet in length, and weighing ten or twelve tons. The most common are a metamorphic, stratified quartzite rock. The metamorphic action has been very thorough, giving the boulders a hardness equal to common quartz, and on that account they are frequently known under the name of "hard heads." . . . The large boulders are usually angular, and not so much water-worn as the small pebbles. Next to quartz rock the most common material is greenstone. A few of granite and syenite are also seen, but seldom as large as the quartzite or greenstone. The deposit of drift material is not deep, being about five feet, though in a few places it is twenty feet. The large boulders are quite numerous on the Pottawatomie reserve, on both sides of the Kansas. They lie on the tops of the bluffs and high prairies more frequently than on the lower lands. (Mudge, 1st Bien. Rep. Kan. St. Bd. of Agri., vol. VI, 2d ed., 1877-'78, pp. 51, 52.)

The Osage prairies have as their distinguishing features a series of terraces which have been formed by erosion of the interstratified Carboniferous shales, sandstones, and limestones. The rocks have a northeast-southwest strike, and the harder beds, being more resistant, produce escarpments which, with many deviations, follow this direction from the Kansas river into the Indian Territory, although none of them extend unbroken for the whole distance. The resistant beds in Kansas are largely limestones, which outcrop at the top of the escarpments and on the surface of which back slopes are developed. In the Indian Territory the limestones disappear and sandstone formations assume their rôle in the topographic features. The line of transition from sandstone escarpments to limestone escarpments is an irregular V, extending northward from the Indian Territory, with its point approximately at Yates Center, in Kansas.

The drainage of the Prairie plain is due primarily to the eastward slope of the surface. . . . In general the dip is westward, and the streams flow at right angles to the strike, but slight deformations of the strata have caused a deflection of some of the streams to the southward. . . . The formations over which the streams flow are beds of limestone, alternating with beds of sandstone and shale. The unequal yielding of these materials to erosive agencies has produced in general a terraced surface, the limestones protecting the escarpments, while the shales and sandstones below have been carried away by the streams. The inclination of the strata has produced a gradual slope (back slope) from the top of one escarpment to the base of the next higher. (Adams, Kan. Acad. Sci., vol. XVI, pp. 56, 57.)

If one passes across the country from southeast toward the northwest, he will be continuously passing up a series of terraces. . . . Here and there, wherever there is a line of outcrops of an important limestone, there is a more or less pronounced escarpment facing the southeast. . . . If the escarpment is bold, and the underlying shale-bed is thick, a series of mounds always exists to the southeast of the escarpment proper. These have plainly been produced by the erosive agencies breaking through protecting limestone further to the west. Such mounds sometimes are large, with broad, flat tops, as is well illustrated by Table mound, northwest of Independence. Sometimes they have the form of a frustum of a cone, so beautifully illustrated in the vicinity of Cherryvale and Mound Valley. At other times, as at both these places, the protective limestone is still maintained on their summits. In some instances the surface limestone has been gradually worn away until the material consists entirely of masses of shale, which may have a little sandstone interspersed. In these cases the summit of the mound is rounded. . . . It is interesting to note how the great areas of mounds and escarpments coincide so exactly with the southeastern limits of the shale-beds. Beginning at La Cygne and Boicourt, we have an area characterized by mounds and steep bluffs, reaching to the southwest by way of Mound City, Uniontown, Cherryvale and Mound Valley to beyond the limits of the state. [To the west there is] a similar topography in the vicinity of Neodesha and Independence. [Passing further along, similar features extend] from Osawatomie to the southwest, by the way of Lane, Greeley, and Garnett. . . . At Lawrence, Blue mound stands off five or six miles to the east of the general outcropping of the limestone which forms its protective cap. . . . We find

but few rolling areas anywhere within the Carboniferous. The tributaries of the different streams have cut the whole country into valleys, and the residual portions, which have not been carried away by erosion, constitute the hills, so that usually there is such a succession of hills and valleys that the whole country is not only well drained, but moderately rugged. While one may travel for miles in the direction of the ridges almost on a level, in a transverse direction deep valleys will be found. (Haworth, Univ. Geol. Surv. Kan., vol. I, pp. 213-215.)

The sandstone beds, which give rise to heavy escarpments in the Osage prairies in the Indian Territory, are succeeded in eastern Oklahoma by softer beds and a succession of formations, which, being generally homogeneous in character, do not give rise to escarpment features. The portion of the Prairie plains lying in eastern Oklahoma may be characterized as the rolling plains, in contrast with the terraced surface of the Osage prairies. To them the name Oklahoma prairies is here given. The area is traversed by streams which flow in a general eastward direction, but which are deflected toward the south. The divides are gentle, and no very decided differences of elevation exist throughout the area. The country rock and soil of this area are generally red, and are a portion of what has been called the Red Beds, which are a color phase of the Carboniferous and Permian formations. The western limit of these prairies is marked by a conspicuous escarpment, known as the Gypsum Hills escarpment, which passes from the Glass mountains, on the Cimarron river, in Oklahoma, to the west of Alva, and thence into Barber county, Kansas. Only a small portion of the Oklahoma prairies lies in the state of Kansas. It is triangular in form, and includes the western part of Sumner and Sedgwick counties, and a portion of Harper and Kingman. The line of division between the Oklahoma prairies and the Great Bend lowland is naturally not well marked by topographic features, but is drawn relative to the area over which the streams have migrated as a result of the local base-leveling of the Arkansas river.

The Arkansas river along its course in Kansas, where it makes what is known as the great bend, flows in a shallow channel. Its valley comprises a broad stretch of generally diversified lowlands, which represents a local base-level of the stream. In this portion of its course the river lies on the easily eroded Paleozoic shales and the shaly beds of the Dakota formations, and, together with its tributary streams, has, in the course of its meanderings, reduced the country to a generally level plain. The western limit is found along the course of the stream from Larned to Great Bend, where it impinges against the Dakota sandstones. Its southern limit lies in Oklahoma, where the river, in passing around the southern end of the Flint hills and eroding its channel across resistant beds, has been confined to a narrow valley. The area of the Great Bend lowland is largely covered

with sandy accumulations, which in places form sand-hills and in other localities are spread out as a thin mantle. The Equus Beds, in McPherson county, belong to this formation. The eastern boundary of the lowland is the line of intersection of the structural plain of the western slope of the Flint hills with the level country of the Arkansas valley, and is not strongly marked by any topographic features. It may be drawn with reference to the occurrence of the limestones, on the surface of which the Flint Hills upland is developed. The Great Bend lowland, considering its elevation and general surface features and its relations to the other divisions of the prairie plains, is a natural part of them, although it forms an arm extending between the uplands of the Great plains.

The explanation of the origin of the great bend of the Arkansas river, given in the following quotation, was outlined by the writer when in the field, and was subsequently embodied by Haworth in his report: "One of the most notable features in connection with the Arkansas river is the great and unusual bend it makes in passing from eastern Ford county so far to the north to Great Bend, and back so far to the south. . . . It would seem that when the river reached the Dakota formation, a formation so easily corraded, it immediately began acting upon it with great vigor. As the general inclination of the strata of the Dakota is to the northeast, . . . and the Dakota sandstones are easily corraded, it would seem that this was the cause of the river's great bend to the north. We may safely believe that at an early period in the history of the river it passed eastward from Ford county across the north of Kiowa, Pratt and Kingman counties, probably passing out of the state not far from its present location. If this explanation is correct, one cannot help inquiring why the river did not break through the upland, in the vicinity of McPherson county, and ultimately join the Cottonwood river through Marion and Chase counties. To answer this clearly, we only have to look at the general geologic character of the southern part of the Flint Hills in Butler and Cowley counties to find an adequate reason. The great Flint hills area has its surface rising to points considerably higher than the main uplands of Sumner and Sedgwick counties. Evidently these high elevations in the the early Tertiary times deflected the river southward, and prevented it from crossing the Flint Hills region when the drainage was first changed to an easterly direction by elevation of the Rocky Mountains. The same Flint Hills area has continuously remained higher than the uplands in Sumner, Sedgwick and adjoining counties. Therefore, with the river once flowing out of the state near where it now does, it would be impossible for it to pass eastward across the Flint hills so long as the elevations remain as they now are." (Haworth, Univ. Geol. Surv. Kan., vol. II, pp. 30–32.)

GREAT PLAINS REGION.

The Great Plains region, or, as it might properly be called, the Great Plains plateau, lies between the Prairie plains and the Rocky Mountains, its limit not being marked by sharp differences of elevation or changes in topographic features. It is crossed by a number of streams which head in the mountains and in their lower portions unite to form the great river system of the Mississippi valley and the inage of the western Gulf coast. The Great plains extend north

and south, including the median portion of these streams, and within their area corrasion varies with the varying conditions of climate and the grade of the country. All of the processes which are now at work are dissecting the Great plains. This has not always been their condition. In Tertiary times the sediments carried from the Rocky Mountains were spread in a broad sheet extending eastward from their base, and built up a constructional plain. This plain is largely preserved to the present time, and constitutes the division known as the High plains.

The elevation of the Great plains increases very gradually to the westward, and their surface is not marked by conspicuous features of relief. Their more rugged portions are where the Tertiary formations have been sculptured into bad lands and cañons, or the areas of the older rocks have been dissected by the streams. The Bad Lands type of topography is found principally along their western border, the High plains, or intermediate portion, being simply trenched by the streams crossing ft.

The Flint Hills upland is a name suggested for a somewhat irregular belt of country which extends from north to south across the state and terminates in a point north of the Arkansas river in Oklahoma. It is in its southern part the divide or watershed between the Neosho and Verdigris drainage on the east and the Arkansas drainage on the west and south. The Kansas river is the only stream which crosses the upland. The Cottonwood river heads within its limits near the western border, and flows eastward, extending nearly across the area The eastern border of the upland is marked by a compound escarpment, which is produced by the outcrop of limestones. This feature is well defined at its southern portion, where it is emphasized by the position of the stream valleys. The removal of the shales, which succeed the highest beds of limestones, has given rise to a structural plain developed on the upper surface of these resistant beds. This plain has a gradual western dip, corresponding to the dip of the rocks, and constitutes the general surface of the upland. It blends along its western border with the Great Bend lowland and the valley floors of the Smoky Hills upland. Its southern portion has suffered considerable dissection, and is known as the Flint hills, from which the name of the upland is derived. The northern portion of the upland is dissected by Little Blue and Big Blue rivers, which flow southward from Nebraska approximately along the strike of the formations. They have developed well-defined valleys, and their numerous short tributaries have sculptured out terraced hills and divides, producing a quite rugged topography.

The Flint Hills upland has no doubt had an influence in determin-

ing the course of the Arkansas river within the state. This stream, after making a peculiar bend, parallels approximately the western border of the upland into Oklahoma, where it finds its way around the south end. The streams of the northern part of the state have likewise adjusted themselves to the structure of the rocks on the western border of the upland, and joined their volumes in maintaining the valley of the Kansas river across it. In determining the disposition of the drainage from the Great plains, the Flint hills upland likewise determined the former distribution of the Tertiary formations by deflecting the streams carrying the sediments, or retarding the velocities of those eroding their channels across its resistant beds and causing them to drop their loads. The eastern margins of the Tertiary formations have been largely removed. Judging from their present extent and relations, as well as the distribution of materials derived from them, we may safely assume that they did not transgress eastward in Kansas farther than the boundary of the Flint Hills upland. The following description of the Flint hills, which present the most pronounced characteristics of the upland, is principally from observations along the railway, extending from Moline to Winfield, crossing their most broken portion:

The Flint hills extend in a general north and south direction, and occupy approximately the southern part of Chase county, the western borders of Greenwood, Elk and Chautauqua counties, and the eastern portions of Butler and Cowley. Fall, Elk and Big Caney rivers, which are tributaries of the Verdigris, have their sources in the many small streams cutting the eastern escarpment of the Flint hills. The streams on the western slope (structural plain) are tributaries of the Walnut. The Cottonwood, a tributary of the Neosho, sweeps in a broad curve to the north, around the head waters of the two drainages above mentioned. . . . The divide between these several streams, with its uneven configuration, is known as the Flint hills. . . . The general position of the ridge may be located on a map by the significant names of the towns—Flint Ridge, Summit, Beaumont, and Grand Summit. In their southern portion, where crossed by this section, the valley of Grouse creek, which extends from north to south, divides them into two ridges, the eastern of which is known as the Big Flint hills, and the western as the Little Flint hills. . . . . To the north of the Flint hills, as here defined, the same geological formations are exposed in the valley of the Kansas river and its tributaries, and give rise to the terraced bluffs which are characteristic of the country around Junction City and Manhattan. . . . The Flint hills derive their name from the large amount of flint which is found over their surface. Nearly all the limestones composing them contain some flint, and a few of them carry heavy beds of it. The weathering away of the limestones has left the enclosed masses of flint, which are strewn over the surface in such profusion as to seriously interfere with travel. . . . The Flint hills owe their contour wholly to erosion, there being no evidence whatever of marked disturbances of the strata, which occupy nearly horizontal positions [with a low dip to the westward]. They are characterized by even terraces and small cañons and gulches. Along the top of the terraces, which are covered

with a scant growth of grass, the various limestone systems are seen in parallel ledges, and are very conspicuous on account of their whiteness. . . . (Adams, Univ. Geol. Surv. Kan., vol. I, pp. 27, 28.)

The higher formations of what is generally referred to as the Red Beds in Kansas and Oklahoma contain resistant rocks at several horizons, and erosion has developed within their area a distinctly different surface from what is found in the Oklahoma prairies. The line of separation between these two divisions is the Gypsum Hills escarpment, already referred to. The topographic forms of common occurrence are small, table-like plateaux and flat-topped hills, which are the minor elements. The area is a dissected upland, with its western border grading to the High plains without perceptible difference of elevation—the rise in surface to the westward being accomplished by a series of steps within the upland. The Red Hills upland has already been well described by several authors. The following descriptions are particularly applicable to them:

In eastern Barber county, in the buttes to the north of Sharon and the Cedar hills to the south, the rugged and picturesque country of the Red Beds begins. . . . This region, with frequent steep buttes and streams lined by steep bluffs, extends across Barber, Comanche and Clark counties to the eastern part of Meade. The best exposures of the middle portion of the series of rocks forming them, as well as some of the most picturesque parts of this country, may be seen in Barber county, in the Cedar hills, and along the steep line of bluffs and hills to the west of the Medicine Lodge river, especially in the Gypsum hills to the southwest of the city of Medicine Lodge. When seen from the hills to the east of Medicine Lodge, at a distance of ten miles, in the early morning sunlight, they form a landscape of striking beauty, which, once seen, will never be forgotten. The reddish color of the steep sides of the hills, whose walls suggest gigantic fortifications, is clearly visible, while the top of the hills appears in the hazy distance like a great table-land. (Prosser, Univ. Geol. Surv. Kan., vol. II, pp. 84, 85.)

If, on the road from Harper to Medicine Lodge, the traveler finds himself looking westward across the valley of Medicine Lodge river, on one of those enchanting days for which southern Kansas yields the palm to no other locality, the autumn air being tinged with just enough of haze to purple the remoter vistas of the ruddy landscape, "The splendor falls on castle walls" which rear themselves seemingly as low mountains or buttressed escarpments of a table-land crowning the further incline of the valley and bounding a considerable part of the western horizon. (Cragin, Colo. Coll. Studies, vol. VI, p. 28.)

The whole country is red. The soil, even where it contains much carbonaceous matter, is ruddy; the sedimentary soil just forming on the steeper slopes is ruddier; flooded rivers glance in the sunlight like streams of blood; steep bluffs and the sides of narrow cañons pain the eye with their sanguine glare The hard ledges are persistent for long distances, and give a definite contour to weathered bluffs and ridges. . . . One of these layers south and west of the Medicine river is persistent over a considerable area. The erosion of the valley has left it nearly at the top of the area in which it appears, showing as an irregular plateau sloping east and north to the river. . . . In the lower valley the western boundary of the white sandstone plateau is a solid wall of red rock rising

Mushroom Rock, Ellsworth county, Kansas. Showing peculiar erosion type in Dakota Sandstone.

above it nearly 200 feet, surrounded by a great white coping of gypsum from twelve to fifteen feet thick. The wall runs southward for several miles, with some openings, and terminates abruptly by a turn directly west. Northward its termination is a bold promontory, and the neck, with gypsum absent from it in places, is only wide enough on the top for one person to walk. From this point the wall retreats, forming a deep amphitheater, with isolated buttes, and towers, and caps, and all up the western valley towers, pinnacles and buttresses are repeated, advancing toward or retreating from the river. When approached, the lights and shadows on the gypsum have the appearance of quaint gables and mansard roofs. (Hay, 8th Bien. Rep. Kan. St. Bd. Agri., vol. XIII, pt. II, pp. 106, 107.)

The portion of the state which is included in the Smoky Hills upland division is the north-central part. It is so named from the Smoky hills, in Saline county, which have also given their name to the Smoky Hill river. The formations found in the upland are the Upper Cretaceous rocks. The area may be referred to as denuded, considered with reference to the country to the west, which is covered with the Tertiary formations. It is not improbable that the Tertiary beds, which form a constructional plain in the western portion of the state, since the close of the period of their deposition, have been removed by erosion from a large portion of the area of the Smoky Hills upland. The topographic features are largely of indistinct-terrace and broken-escarpment type, with occasional lone hills or mounds. Along the southeastern border there are a number of places at which the more resistant sandstone horizons of the Dakota have given rise to features such as Pawnee rock, in Barton county; Smoky Hill buttes and Soldier Cap mound, in Saline county; and the Pulpit rocks, resembling perched glacial boulders, at Rock City, Ottawa county. Similar hills and groups of mounds occur in Lincoln, Ellsworth and Russell counties, being there also formed by Dakota sandstones. The upland is traversed by a large number of streams flowing eastward in nearly parallel channels and having moderate valleys The divides between them have a general uniformity of broken slopes and gentle terraces. The rocks which constitute them outcrop principally along the streams as bluffs, and in places form the walls of cañons. The area of the Benton formation is more regular in its topographic features than the Dakota, since it consists of interstratified limestones and shales of a quite uniformly varied character. Toward the western border of the upland the Fort Hays limestone and Niobrara chalk (which succeeds it) are the protecting element in what is known as the Blue Hills escarpment. The Blue hills proper are generally considered as occurring in Russell county and extending to the north and south for some distance. The same general feature extends along the entire line of outcrop of the formations, and the name is here extended to the escarpment produced by them after

beds of Benton shales underlying the resistant limestones are known as the Blue Hill shales, from the same locality. It is the erosion of these beds which gives rise to the escarpment.

Across central Kansas, from north to west of south, stretches a belt of country marked in ravines by rugged sandstone rocks and by long, rounded slopes on the prairie. This belt belongs geologically to the part of the Cretaceous system known as the "Dakota formation." To travelers on the Central Branch railroad, passing through Washington and Cloud counties, these sandstones are conspicuous objects. On the line of the Kansas Pacific, the same sandstones, underlain by colored shales, make the wild country from Bavaria by old Fort Harker to Ellsworth. . . . Further north, in Ellsworth county, are ravines with precipitous sides, on some of which a lost race have carved hieroglyphics of war and travel; and there are huge single rocks, like giant pulpits, standing out and alone. In Russell county are the worn pinnacles and crags of Rock City, and in Ottawa county the quaintly rounded concretionary masses of another rock city. . . . (Hay, 8th Bien. Rep. Kan. St. Bd. of Agri., vol. XIII, pt. II, pp. 109, 110, 111.)

A large portion of western Kansas is included in the High plains. Their eastern boundary is defined by the Blue Hills escarpment in the northern part of the state. South of the Arkansas river they merge with the undissected western margin of the Red Hills upland. The western limit of the High plains lies well toward the foot-hills of the Rocky Mountains, in Colorado. Their north and south extent has not yet been defined with any degree of definiteness. They correspond with what has sometimes been called, for convenience, the Central plains, and form an irregular belt midway in the long eastward slope of the Great plains. They are characterized by a general dead-level surface when viewed in their broader aspect. Their surface is a constructional plain, which has survived in large measure since the close of Tertiary times. The divides between the streams are flats or fragments of an extended surface which was formed by the spreading of a quite even mantle of Tertiary sediments over the older rocks, which are principally of Cretaceous age. The valleys, which are scored into the Tertiary and often expose the Cretaceous, are relatively but slight furrows compared with the broad extent of level land. Along the larger streams, however, are found occasional striking erosional forms, which are all the more conspicuous because of their occurrence in the High plains. Cretaceous formations, which are exposed where the rivers have cut through the Tertiary beds, give rise to cañon walls along the small tributaries, and in the broad valleys remnants of them occur as bluffs and standing rocks. The Dakota is seen at Point of Rocks, on the Cimarron river, in Morton county, and the bluffs on Bear creek, in Stanton county. The Benton and Fort Hays limestones occur along the bluffs of the Arkansas river and its tributaries in Hamilton county. The Niobrara, however, gives rise

to by far the more picturesque features. It is exposed on White Woman creek, in Greeley county, at Wild Horse corral, and at many points along the Smoky Hill river. The Niobrara chalk has the peculiarity of weathering with vertical walls where it is of homogeneous character, so that in many places it has been eroded into picturesque landmarks. Castle rock, in the valley of the Hackberry, about ten miles from its mouth, is a lone pyramid composed of this rock, and separated by a considerable interval from the main bluff. Monument rocks, on the Smoky Hill river, are famous landmarks, and formerly a stage station of the overland route was located at them. Another picturesque group of rocks, which at a distance resembles the ruins of many castles, is situated west of Elkader, in the Smoky Hill valley. The Fort Pierre shales in Sherman county have been eroded into a number of hills, which are capped with Tertiary conglomerate. In traveling across the High plains one recognizes the fact that they constitute the typical portion of the Great plains. The following description is applicable to the High plains not only in Kansas but in their extent beyond the limits of the state:

> The High plains, of unconsolidated material, above grade, and exposed to a considerable precipitation, are held by their sod. . . . The great plateau surfaces of the High plains have to show no systems of drainage, because, presumably, from the commencement of the present erosive stage, they have been sod-covered, as at present. In other words, the High plains have endured as alluvial plateaux since Tertiary times, or at least since the opening of the Pleistocene. While degradation is at a standstill upon the plateau surfaces, the topographic belt which they constitute has, however, been appreciably narrowed within a corresponding climatic belt by marginal recession. The limiting bluff, especially, that faces eastward, is carried backward by sapping on the part of small streams or feeble beginnings of streams, originating in springs and "seeps" at the bluff foot. . . . Agreeing generally in position with the topographic subdivision of the High plains is also a subdivision by climatic difference. In their westward rise of thousands of feet, the Great plains pass through climatic gradations from humid to arid. . . . (Johnson, 21st An. Rep. U. S. Geol. Surv., pt. IV, pp. 610, 629.)

LIST OF FOSSIL PLANTS COLLECTED IN THE VICINITY OF ONAGA, KAN.

By F. F. CREVECŒUR, Onaga, Kan.

Read (by title) before the Academy, at Topeka, January 2, 1903.

AS a list of fossil plants without any information as to the horizon from which they were collected would be of but little value, the following geological notes are submitted.

Accepting the Cottonwood Falls limestone as the dividing line separating the Permian from the Carboniferous, we have in Mill Creek township, in which the town of Onaga is situated, only the outcrops of the highest horizons of the latter formation. The Vermillion river with its tributaries has cut a deep trench from north to south through near the middle of the township and removed all trace of the Cottonwood Falls series of limestone from within the township, but the latter outcrops near by, in the next township west (Lone Tree), and a remnant remains on the hill in Lincoln township, about twenty rods east of the southeast corner of Mill Creek township.

The Eskridge shale, the highest series of the Carboniferous, with its underlying Neva limestone, exist only as remnants in the northeast and southeast corners of the township.

Below the Neva limestone, as measured in a section (fig. 1), along the south side of the southeast quarter of section 2, township 6, range 11, there exists a series of yellowish, ferruginous shales of a thickness of forty-five feet eight inches. This is 10 in figure 1, and is the horizon bearing the fossil plants so far collected.

Next below this is a limestone (9 in our section), consisting of two layers each nine inches thick. The upper layer weathers into whitish angular fragments, which once seen are easily recognized, and forms a horizon easily traced and from which others may be identified. Below this limestone is a stratum of dark blue shale eleven and one-half feet thick. This shale (No. 8) becomes much lighter colored by exposure.

Next below this shale occurs a series of limestones (No. 7) which, from an economical standpoint, we consider worthy of a designation, and from its occurring over most of the township and within the limits of the town of Onaga, where it has been extensively quarried for material of which some of the town's most substantial buildings have been built, we propose the name Onaga limestone. This, like the Neva limestone above, outcrops in bold bluffs, and consists of four layers. The first, or highest one, is a brown-colored stone five inches

thick, and has its upper surface much pitted from decomposition where it comes in contact with the overlying bluish clay shale. The next layer is also brown, of a thickness of eight inches, and is much harder than any of the other layers of the series. Where deeply covered, these two layers merge into one. The third layer is a bluish-gray stone, six inches thick, and has both surfaces covered with a soft, light-colored coating, the result of decomposition. The fourth and last layer is a light blue stone eight inches thick. Its under surface is studded with bumps or prominences one to two or more inches high. The stone is the purest in lime of any of the limestones of this locality, and, with the layer above it, has, in an early day, been burned for this product to a considerable extent.

FIG. 1.

No. 1 is a seam of coal about ten inches thick. No. 2, about twenty-three feet, No. 4, thirty-one feet three inches, No. 6, two feet, and No. 8, eleven feet six inches, are dark-blue shales. These shales are much lighter colored in some other places. No. 10 is a yellowish shale, plant-bearing. No. 12 is the Eskridge shales. No. 3 is a stratum of limestone, twenty-eight inches. No. 5 is thin limestone, from two to four inches. No. 7 is the Onaga limestone, twenty-six inches. No. 9 is limestone, eighteen inches. No. 11 is Neva limestone, from two to four feet.

Below this series of limestones there is another stratum of dark blue shale (No. 4) thirty-three feet eight inches thick. Near the top, a foot or two below the overlying limestone, there is a thin seam of flinty limestone (No. 5), from two to four inches thick, which weathers into perfectly rectangular blocks. Both surfaces are remarkably smooth, and it would make nice flagging stone if it only was more plentiful. Near the base of the shale-bed mentioned above there occurs a stratum of purplish clay, which helps to identify the limestone at the base of the shale-bed. This limestone (No. 3) consists of a variable number of layers. As measured in our section just above the bed of the creek, it consists of eight inches of stone, underlain by four inches of shale, separating it from the next two underlying layers of limestone, each ten inches in thickness. This series of limestones weathers into cubical blocks, which form good material for bridge abutments.

Below this limestone (No. 3) are about twenty-three feet of dark shale, with a seam of coal at its base. This coal (No. 1) varies in thickness from

four inches, as found in wells in Onaga, to ten or more inches on French and Mound creeks, in this township, and on Coal creek, in Grant township, to the east. In places the coal is overlain with a dark, tough stone about six or seven inches thick.

The different limestone strata contain fossils in varying abundance. The Neva limestone usually has its surface covered with numerous *Fusulina cylindrica*, half an inch to a quarter of an inch long. Limestones Nos. 3, 5 and 9 do not as a rule contain many fossils, but No. 7, the Onaga limestone, has many fossils, consisting of species of *Lophophyllum*, *Productus*, *Enteletes*, *Pinna*, *Reticularia*, *Allorisma*, *Spirifer*, and many crinoid stems. Fossils, with one exception, have not been found in any of the shales. In a well dug a mile south of where our section was measured, in shale-bed No. 10, and what we should judge to be near the base of the shales, there were found many specimens of a species of a *Productus*. It is in this bed of shales, as has already been mentioned, that our fossil plants occur. In several wells sunk about a dozen rods west of the quarter stone on the south side of section 2, township 6, and range 11, numerous plant remains have been unearthed at a depth of from seven to eighteen feet. A quarter of a mile north of the above-mentioned corner-stone, while digging a pond, quite a number of species were also collected, but in less numbers than at the first-named locality. The species collected at the wells consist of the following:

1. *Mariopteris;* probably *M. cordato-ovata* Weiss. var. *obtusa.*
2. *Odontopteris;* probably *O.* (*Lesquereuxopteris*) *moori* (Lx.) Dw.
3. *Daubreea;* perhaps two species.
4. *Neuropteris scheuchzeri* Hoffm.; a variety not yet described.

Besides these there are a number of others not yet identified. At the pond were collected the following species:

5. *Annularia stellata* (Schloth.) Wood; narrow form.
6. *Asterophyllites equisetiformis* (Schloth.) Brongnard.
7. *Neuropteris odontopteroides* F. & W.?
8. *Neuropteris plicata* Sternberg; as applied by Lesquereux.
9. *Neuropteris scheuchzeri* Hoffm.; same as No. 4.
10. *Neuropteris* sp.; apparently a new form.
11. *Odontopteris brardii* Brongn.
12. *Pecopteris hemitcloides* Brongn.
13. *Pecopteris newberriana* F. & W.
14. *Pecopteris oreopteridia?* (Schloth.) Brongn.
15. *Radicites capillarens* (L. & H.) Pat.

Of the species collected at the pond, Nos. 5, 6, 11 and 15 were not recognized at the wells, though species, which may be forms of Nos. 5 and 8, were also found at the last localities. Also, the species of *Daubreeas* which occur at the wells were not seen at the pond.

It was ascertained that the outcrops of the different strata on the

east side of the creek occur at practically the same level as on the west side. Supposing them to be continuous over the territory studied, where not removed by erosion, the Neva limestone should have been found at a depth of four and a half feet in the last well dug near the quarter section-corner. Instead, the underlying shales outcrop at the surface and plant remains were first met with at a depth of seven feet, or just beneath the level of the under surface of the Neva limestone series, should this have been continuous. The yellow shale continues at this place to a depth of eighteen or nineteen feet, when it is replaced by the blue shale, which should not be encountered until a depth of about fifty feet. This shows that the shales underlying the Neva limestone were deposited to a greater thickness at this locality than elsewhere in this territory, thus forming conditions inimical to the deposition of the Neva limestone at this place. The different strata of shales are considerable arched, and tend to show that this immediate locality was above water while Neva limestone was deposited, and that the latter was laid down in comparatively shallow water.

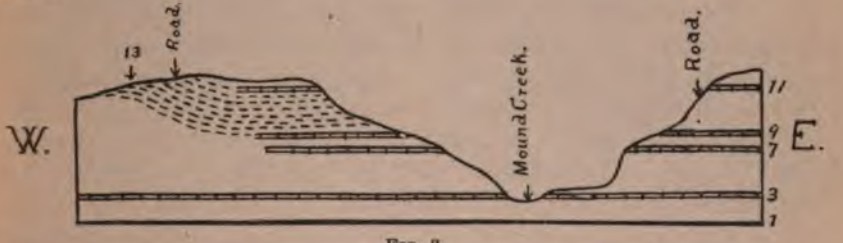


FIG. 2.
Numbers at right correspond with those in fig. 1. No. 13 is one of the plant-bearing localities.

Figure 2 shows the uparching of the plant-bearing shales at 13, being the well mentioned above. This figure represents a horizontal section as measured at the locality for figure 1, and extends for a little over a half-mile east and west across Mound creek. Another well was dug some years ago about thirty rods north of the well shown at 13, figure 2. The surface at this well lies twenty-four feet below the surface of the well at 13 and was dug to a depth of twenty-two feet. Instead of the yellowish, clayey shale, which should have been encountered, there was at the surface eight feet of glacial till, with boulders, followed by eight feet of finely stratified sandy silt. Below this to the bottom of the well occurred cross-bedded sandstone, the higher horizons dipping to the west while those at the bottom of the well dip to the east. The blue shale was not reached in this well, but from another, dug lower down the slope, it was reached at a depth of about eighteen feet, or at its proper horizon.

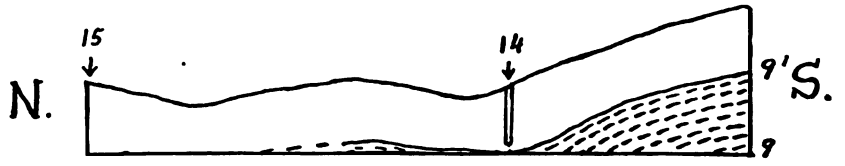


FIG. 3.

No. 9 represents the horizon at which limestone (No. 9, figs. 1 and 2) should appear. No. 9¹ represents the upper surface of the dark blue shales, which first make their appearance in the vicinity of limestone No. 9. No. 14 is a well twenty-two feet deep which did not reach the blue shale. No. 15 is the pond where fossil plants were found.

Figure 3 represents a north-and-south section, measured for a quarter of a mile north of the well shown at 13 (Fig. 2.) At 9 is shown the horizon at which the blue shale should be first met with, while at 9¹ is shown its upper surface as it actually exists. At 14 is shown the well which was dug through till and sandstone, in which the blue shale was not reached. At 15 is the pond in the bottom of which plant remains were found.

It was at first thought that the Americus limestone, as shown in Mr. Alva J. Smith's geological section across Lyon county, shown in the last volume of the Transactions of the Academy existed here, but a careful comparison of our section with Mr. Smith's of the strata immediately underlying the Cottonwood Falls limestone shows the two to be nearly identical, the differences consisting of greater thickness of the limestones in Lyon county, with the exception of our No. 9 (fig. 1), which is exactly the same thickness as the corresponding limestone in Lyon county, this being the second limestone below the Cottonwood Falls limestone in Mr. Smith's section, and the lesser development of the shales in that county. Mr. Smith's section does not show the seam of coal occurring at the bottom of our section, but the stone corresponding to the one just overlying our seam of coal is shown in an eight-inch seam in his section.

Acknowledgments are due to Dr. David White, of the National Museum, for the determination of the plants in this list, and to Dr. Geo. I. Adams, of the United States Geological Survey, and Mr. Alva J. Smith, of Emporia, for assistance in locating the strata of our section.

Shale Bank on the Smoky Hill River.

GOLD IN KANSAS SHALES.

By J. T. Lovewell, Topeka, Kan.

Read before the Academy, at Iola, December 31, 1901.

THIS paper might be written very briefly, like the celebrated chapter on "Snakes in Ireland," by saying: "Gentlemen, there is no gold in Kansas shales." Such a summary, though delightful for its pedagogical positiveness, appears to me lacking in the element of truth; therefore unworthy of the consideration of this scientific body. In what follows, I will endeavor to state to what extent gold has been proven to exist in the shales along the Smoky Hill river in Trego and Ellis counties, and sketch briefly the extent and manner of investigation pursued under my observation.

We find in these shales abundant evidence that the region was once an ocean bed; that the shales are sedimentary deposits, which, by upheavals, by the plowing of glaciers, by the washing of prehistoric rivers, have in process of time reached the condition in which we find them.

The Smoky river, cutting its way through the shale-beds, reveals the stratification to some extent. Near the surface there is usually a hard, compact layer of fossiliferous limestone, from a few inches to a foot in thickness. Below this, the shale is softer and darker in color and more or less filled with fossils of the Benton group. Sometimes it is in thin laminations, and there will be a layer of an inch or two in thickness of yellowish material, coming probably from oxidation of pyrites. Other hard layers of compact limestone occur at irregular intervals, and this formation extends to a depth of several hundred feet, perhaps. It has been stated to me by four or five creditable witnesses that gold has been panned from the sands of the Smoky by the early gold-seeking emigrants on their way to Colorado; also, that gold has been found in several instances in sands from wells in this region.

From the United States government report published in 1848, we learn that attention had been directed in this Smoky Hill district, and a map from this report, which I have the pleasure of showing you, designated the place where is now the Smoky Hill town site as a point from which tin was obtained. The report indicates a doubt as to whether the metal they obtained was tin or zinc.

The late Cyrus K. Holliday, led by these reports and traditions, joined with a Mr. Stotz in outfitting a prospector named Ephraim Baker, who explored the region and obtained samples, which were

sent to Chicago and Denver for assay. One of the certificates, in my possession, from the Chicago and Aurora Smelting and Refining Company, reports a value in gold of thirty-two dollars, and silver twenty-five cents, per ton. Baker's find was about seven years ago, and attracted considerable comment.

More or less scientific investigations ensued, and from that date until now very different conclusions have been reached. Assayers from the Atlantic to the Pacific have tested these shales. Many of them have reported absolutely no trace of gold. This class agree in results. From the rest of the tests, which vary all the way from traces up to fine values of gold and silver, worth as much as fifty dollars per ton. These persons do not agree with each other to any marked extent, and often the same assayer will find very discordant returns from the same specimen. What shall we conclude from such testimony?

In the first place, considering the sedimentary deposit where gold is found, there is a probability that it may contain anything that is found in sea-water. From several tests, I have found that the dry shale will lose about nine per cent. when heated for some time to 350 degrees centigrade. The volatile matters given off were water vapor (of crystallization) and petroleum-like substances. When heated to redness, I obtained vapors of zinc oxide.

Without undertaking to determine how the gold got into the shale, whether by precipitation from the sea-water or by alluvial deposit, it is certainly in a very fine state of division. When the shale is pulverized to 100 mesh and carefully washed with water, a residue is found which, under the microscope, shows grains of silica and pyrite and some grains of gold. Some residue yields a quantity of gold on assay, which shows that plain washing with water will produce considerable concentration of values. In the washing process, it is likely that we lose some of the very finely divided gold.

In my investigation of this shale, many modes of assay have been tried. The ore has been roasted with various kinds of fluxes before assay, and in a good many cases this preliminary treatment has been useful. In the spring of 1899, cooperating with Doctor Franklin, at Lawrence, we made over 100 assays of shale, which had been obtained from a number of different places. Many of our results were blanks, but a few showed small values in gold. In the following summer—that is, two years ago last summer—I went to the Smoky valley and took shale from many places up and down the river for several miles. I brought my specimens to Topeka and worked on them for a month, making over 100 assays. This gave small values, the last twenty averaging about one dollar to the ton. In these two series of assays, the

number of blanks were greater than the number which showed values, but the shales were taken from all parts of the formations, and many of them doubtless contained no gold. Since then I have made many hundreds of assays, and I suppose the average values obtained are two dollars or three dollars a ton.

One series of sixty-six assays made last summer gave an average of $2.58 per ton. In my laboratory, recently, by concentration methods, 144 assays gave an average of $13.52 per ton. This last series of assays was joint work of several persons, all of whom were solicitous to find the exact truth, and there was no intentional error; but in work divided among several people, no one can be absolutely certain.

Last July Mr. F. H. Blake, of New York, obtained samples of shale, and had twenty-five assays made from as many different specimens by Mr. Henry E. Wood, of Denver. Six of these showed no gold, ten showed traces, and nine gave values ranging from twenty cents to sixteen dollars a ton.

In my laboratory last week, Mr. S. B. Edwards, a chemist of Colorado, made nineteen assays and obtained an average of $2.08 per ton. His highest value was $18.78, and the lowest forty-two cents per ton. His work was done on thirteen specimens collected from the shale banks by himself. I might multiply assay records of this kind, but I have given a fair sample of those which have come to my notice. The most puzzling part of the investigation is that from the same pulp, mixed as carefully as we know how to do it, very discordant values will appear. They have varied as much as fifty dollars per ton.

I have but two hypotheses to account for this discordance. The first is that the gold is not uniformly distributed, and that unwittingly, in taking our assay, we get a rich portion one time and a lean portion another. This may be true, but to one knowing the care taken in mixing the ore it does not seem likely, and is contrary to the experience of those who sample ore for commercial purposes. The other hypothesis is that, owing to the unknown and peculiar conditions of the ore, very likely to its fine divisions, the values in one case are led away by heavy vapors, while in another instance the values are in some way retained.

It may be suggested that fraud has been perpetrated in getting these results, and even if the assay is honest, others, less scrupulous, have had a share in the work. But the same experience has fallen to quite a number of assayers who are working with the greatest circumspection on specimens taken by themselves from the shale-beds.

There are other methods of analysis besides fire assays that I have tried on shales. My experiment with the chlorination process met with the following difficulty: The [illegible] roasted with sodium chlo-

ride. When transferred to the leaching vat, and solution of potassium permanganate and sulphuric acid added, the whole mass hardened as though it had been hydraulic lime, and we could not leach it. When a solution of cyanide of potassium with salt and hydrochloric acid is stirred up with the pulverized shale, the gold and silver will dissolve as cyanides. This is the method used by the Gage people, who claim to have obtained considerable quantities of gold from the shale. I have tried the process pretty thoroughly, and in repeated instances have I found a little gold, but nothing to compare with the results of Mr. Gage.

By long digestion of an assay ton of shale in aqua regia, then diluting and filtering, I obtained a solution which, saturated with hydrogen sulphide, gave a dark precipitate which was incinerated with the filter paper, fluxed, and cupelled, yielding 0.19 mg. of gold, representing a value of $3.80 per ton. The shale used in this experiment was brought to me, and I had no definite knowledge of where, how or by whom it was obtained, though it had the appearance of ordinary shale.

Several electrical processes have been applied to the extraction of metals from the shale, and the values obtained by these processes are higher than by any other. Besides this, they check each other better, and are interesting as another instance of where this wonderful agent, electricity, has become an handmaid to the arts.

Of the electrical schemes proposed, I will mention two. The first is the patented process devised by Mr. Motz, of South Carolina, and used by him in the gold mines there. The crushed ore is made into a sort of thin paste with water and potassium cyanide, and in this condition allowed to flow between several pairs of electrodes, through which electrical currents of the desired strength are made to pass. The metals are deposited on the cathode plates of amalgamated copper. Mr. B. F. Johnson went to South Carolina to investigate this scheme, taking quantities of shale with him. He saw the mill work under Mr. Motz's direction, and three runs gave, in one case, more than seventeen dollars per ton. A brother of the inventor, who lives at Hays, has formed a company to put this process into operation on the ground.

The other electrical scheme of which I speak is devised by Dr. Ernest Fahrig, of the Commercial Museum of Philadelphia. Doctor Fahrig is well known as one of the leading metallurgists of the country, having the advantage of high scientific attainments and long experience. I count myself fortunate in being permitted at this time to read his report, made to the gentlemen who employed him to visit Kansas and examine the shale deposit.

From these considerations, I am convinced that vast quantities of the precious metal are to be found in the Kansas shales. The questions remaining to be solved are: First, how can they be commercially extracted? Second, what is the extent of the deposit and the uniformity of the distribution? Third, if gold can be mined along the Smoky river, in Ellis and Trego counties, is it likely to be found in sedimentary deposits in other places?

In the earlier search for metals in this region, zinc was the one principally sought. No one who seeks intelligently fails to find zinc in the shales. I have tested many specimens which have fifteen per cent., and others which gave but a trace. All my tests show the presence of zinc in some quantity, but the amount is variable.

In October, 1899, M. J. Rattle, of Cleveland, Ohio, reported a value of 31.61 per cent. of zinc obtained from the shale, and, in the letter accompanying the report, expresses the greatest certainty, as well as surprise, at the result. Mr. B. F. Johnson and others, by roasting the shale and driving off and condensing the vapors, obtained a pound or more of fairly pure zinc oxide.

I have of late given but little attention to the zinc constituents of the shale, but, if treated for gold or silver, zinc may become a valuable by-product. There is also no doubt that mineral paint of the best quality can be made from the tailings, after the metal values have been extracted by the electrolytic processes.

As we stated at the outset, all elements found in sea-water might be expected as possible constituents of the shales. We know how some of the rarer elements have been discovered in residues from the salt manufactures, and in the shales we have the residues of the ages. As a purely scientific problem, I know of none more interesting than to find out what the shales are made of.

As we traverse these plains of western Kansas, where the shales are so impregnated with petroleum and bituminous products, the possibility of underlying deposits of oil, gas and coal must occur to us. That can only be determined by boring deep holes, and this will be done before many years. It is possible that some of our geological theories will have to be revised if these things are true, but that need not harm us, and geology is far from being an exact science. It is well to maintain a proper conservatism and have due caution not to be imposed upon by fakirs and sharps; but there are instances in history of carrying doubts and skepticism too far, and I appeal to the fairness of the members of the Kanssa Academy to say if this question of gold in Kansas shales does not demand most careful investigation.

GOLD IN KANSAS.

By J. T. Lovewell, Topeka, Kan.

Read before the Academy, at Topeka, January 1, 1903.

LAST year, at Iola, I had the honor to read before this Academy some thoughts and records of investigations on the subject "Gold in Kansas Shales." To-day I come before you with a more general proposition, "Gold in Kansas." In the discussion of last year's paper, it was urged that the Kansas Academy of Science could not afford to accept the conclusion that gold existed in the shale-beds along the Smoky river, but, as a concession, a committee was appointed to pursue the investigation. This committee has failed to report, and the present paper will only give some of the facts that have come to my observation during the past year. Many fire and other assays of the shale have been made in my laboratory during this period, but nothing from them specially important can be added to the record already given. The shale from one locality at least, "Section 15," seldom fails to give values in gold. These are generally small, but we find some returns as high as ten dollars, and the average is about $2.50 per ton.

In last year's paper I was permitted to quote from Doctor Fahrig's report of his first series of experiments on Kansas shales. Encouraged by that report, means were provided for repeating these experiments on a larger scale. A test mill was erected here in Topeka, and a committee sent to ship from the shale-beds to Topeka a car-load of shale. From this material, Doctor Fahrig made, last April, fourteen mill-runs of about 1000 pounds each, and in due time submitted the results in an exhibit which I am happy to be able to place before you. It shows the gold and silver actually obtained from each run, and gives their values and the value per ton of the shale as thus shown.

The table printed at top of next page shows these facts so concisely that I cannot do better than to reproduce it.

Doctor Fahrig has been engaged to resume this work on a much larger scale and with more publicity. Last year it was deemed best to keep the mill closely guarded from public inspection, and no one was allowed on the premises except Doctor Fahrig with two assistants, and a small committee to supervise the work. In the coming series of experiments, the work at the mill can be seen by any one who has a legitimate interest in it, and the shale tested will be from several localities, since it is not settled yet whether the values lie in streaks or are uniformly distributed. The experiments will go far to settle

Kansas shale from Trego county, Kansas. Assays of fourteen mill-runs, by Dr. Ernest Fahrig, August 12, 1902.

No.	Date.	Class of ore.	Actual weight, lbs.	Weight of gold.	Value of gold.	Weight of silver.	Value of silver.	Value per ton.	Actual value.	Exhibits.	
										Gold.	Silver.
1	April 11	From bin...	1,000	4	$0 16	112	$0 14	$0 60	$0 30	I	A
2	" 14	" " ...	1,000	15.7	62.8	617	77	2 80	1 40	II	B
3	" 15	" " ...	100	6	24	80	10	6 75	34	III	C
4	" 16	" " ...	1,000	25	1 00.4	320	39	2 80	1 40	IV	D
5	" 17	" " ...	1,000	19	76	552	69	2 90	1 45	V	E
6	" 18	" " ...	400	17	68	288	36	5 20	1 04	VI	F
7	" 19	" " ...	1,000	18	72	464	58	2 60	1 30	VII	G
8	" 21	" " ...	1,000	14	56	432	54	2 20	1 10	VIII	H
9	" 22	" " ...	1,000	15.3	61.2	410	51.3	2 25	1 13	IX	I
10	" 24	Committee,	1,000	23	92	424	53	2 90	1 45	X	K
11	" 25	Special.....	1,300	7	36	336	42	1 20	78	XI	L
12	" 26	"	1,200	12	48	288	36	1 40	84	XII	M
E	" 29	Select from bin,	2,000	21	84	208	.....	1 10	1 10	E	N
14	May 2	From bin...	2,000	26	1 04	344	.....	1 47	1 47	XIV	O

All the shale contains more or less zinc and asphaltum petroleum.

the question of cost of extraction, and this of course is the crucial point of the whole investigation.

Doctor Fahrig's process is electrical and its principles are well known to metallurgists, though he has devised appliances which exhibit uncommon mechanical skill in handling the ore.

For an electrolytic fluid Doctor Fahrig makes use of a substance discovered by himself, and named bauxogen. He has found this substance possessed of very unusual and useful properties, aside from its utility as an electrolyte. The exact constitution and mode of manufacture of bauxogen is his secret, and he is confident that if made on a large scale its cost will not be prohibitive. Since a compound such as this cannot be protected by patent, his only chance to profit by his discovery seems to be to keep the mode of making bauxogen to himself.

Among the shale experimenters during the past year, I may mention Waldemar Lingren, sent out from the government chemical department, at Washington. He visited the Smoky valley last June, and took back to Washington specimens of shale from several localities. His report indicated that the shale was subjected, at Washington, to the usual fire tests, and with the usual results, viz.: Many blanks, some small values of gold, and a few that were encouraging. Lingren discovered no trace of zinc, and concludes that, while the shales may contain some gold, the amount does not justify the expectation that it will be found in paying quantities. A report from a government expert doubtless carries much weight, though I am not aware that Lingren employed any methods or used any skill that may not be reproduced by many less known chemists.

Fire assays, at best, are but crude processes, and are liable to many errors. One common source of inaccuracy is the presence of sub-

stances which volatilize in heavy vapors that may carry off, mechanically, fine particles of metals whose recovery is sought. As an illustration of this, I have here an ore from a mine in Arizona which carries a large body like this specimen. It shows readily to the eye crystals of the sulphides of zinc and lead. The larger of these constituents is the blende, which prevents wholly the recovery of lead in a fire assay, although by the wet method ten per cent. or more of lead is found. Likewise, the fire assay of this ore fails to show more than one dollar per ton of gold. By pulverizing and washing, however, the galena may be largely separated from the blende, and now, by the fire assay, the residual galena will show eighty dollars per ton of gold, or about ten dollars of gold per ton on the whole mass of ore.

Now, this shale contains some five to ten per cent. of hydrocarbons of the asphalt-petroleum order. It also always contains a quantity of zinc, which varies much in different specimens.

I attribute to these volatile constituents of the shale much of the discordance in our results, although the gold may also be very irregularly distributed.

During the past year I have had occasion to test other specimens of Kansas minerals for gold and silver. My results tend to confirm the belief that gold is one of the most universally distributed of all the metals. I have examined shales from quite a number of localities and found a little gold in a good many instances, but not generally so much from other places as from that which is found along the Smoky river. I have found some gold in the sand from several places in western Kansas, and in pyritic rocks, wherever they occur, gold is likely to be a constituent. This "fool's gold" still leads many people to think they have discovered a gold mine. The assays from these rocks vary from blanks to as much as fifty dollars per ton, but in none of these cases have I yet found evidence of such ore in quantity giving it a commercial value. The rocks from the bluffs up the river from the Rock Island depot have some gold, and in selected specimens from what may be called pockets in these rocks I have found good values. Many of the glacial rocks in this vicinity have been found to contain gold, and some have thought it possible that some time extensive gold deposits may be found along these old glacial moraines.

One of the latest of gold deposits to which my attention has been called is situated two and one-half miles north of Wamego. This locality is one of those which has lately been considered a promising place to explore for oil, gas, or coal. I was asked to inspect a shaft which has been sunk twenty-five feet deep within about fifty feet of Rock creek, a little stream along whose bed are the outcroppings of a

Shale Bank near the Smoky Hill River.

peculiar mineral formation, which probably led to the sinking of the shaft. The shaft goes through a yellow, clayey loam for about ten feet, and then comes a dark colored, hard, finely laminated layer about twelve feet thick. This is interspersed with nodules and crystallizations of marcasite, from the size of shot to a pound or two in weight. The whole layer seems to be largely of the same mineral, oxidized and broken down in its crystallization. This deposit has been submitted to assay by many metallurgists, and found to contain gold and silver. The amount is encouraging to the belief that, with a sufficient amount of the material, we have here, at least, a deposit, where smelting furnaces will soon be producing Kansas gold in paying quantities. The realization of this possibility depends on the extent of the deposit, or how broad is this blanket of which the twelve feet in the shaft is a small section. Below the twelve-foot hard layer we come to a soft gray shale, filled with fossils of the coal formation. The marcasite nodules make from two to ten per cent. of the whole mass of the twelve-foot layer, and they carry more value than the rest in proportion to weight. Investigations are in progress—first, to determine as nearly as possible the proportions of nodules and stratified matter and their respective average values; and second, what is the area of the twelve-foot stratum.

The chief interest in this section at present is the quest for oil, gas, and coal, and borings will soon be made within forty rods of this shaft. There are many things to favor the idea that abundance of oil and gas will be found in northeastern Kansas. The water in bottom of the shaft shows traces of oil and a little farther north, in Westmoreland considerable crude petroleum has been collected from the surface of water in pits of no great depth. At a mill-pond in Louisville, one-half mile from the shaft above mentioned, an inflammable gas rises through the water and large bubbles of it collect under the ice in winter. The boys cut holes in the ice and light the gas with a match. In the development of the mineral resources of our state much depends on abundance of fuel. With the discovery of such gas-wells as those of Iola, their locality will become likewise the seat of cement works and smelting furnaces.

There are great possibilities in the mineral deposits of the earth, and there is sufficient *terra incognita* to satisfy the ambition of explorers and the cupidity of seekers after wealth. There are risks in this search for mineral wealth. There will be many failures and few successes, but when the latter come the former are little considered.

The search for Kansas gold ought not to be discouraged, for it exists in various deposits, and, even if never found plenty enough to pay for extraction, the search is sure to reveal some form of mineral wealth worth all its cost.

IV.

BIOLOGICAL PAPERS.

"Loco Weed."
By L. E. Sayre, of the University of Kansas, Lawrence.

"Notes on the Trees, Shrubs and Vines in the Southern Part of the Cherokee Nation."
By C. N. Gould, of the University of Oklahoma, Norman, Okla.

"A Provisional List of the Uredineæ of Bourbon County, Kansas."
By A. O. Garrett, Salt Lake City, Utah.

"Statistics about Kansas Birds."
By D. E. Lantz, Manhattan.

"Notes on the Birds of Kansas."
By Dr. F. H. Snow, of the University of Kansas, Lawrence.

"A New Species of Fish."
By F. F. Crevecœur, Onaga.

"Notes on the Food Habits of California Sea-lions."
By L. L. Dyche, of the University of Kansas, Lawrence.

"Food Habits of the Common Garden Mole."
By L. L. Dyche, of the University of Kansas, Lawrence.

"List of Insects Collected in Hamilton and Morton Counties, Kansas."
By Dr. F. H. Snow, of the University of Kansas, Lawrence.

"Additions to the List of Kansas Coleoptera for 1901 and 1902."
By W. Knaus, McPherson.

"A Preliminary List of the Diptera of Kansas."
By Dr. F. H. Snow, of the University of Kansas, Lawrence.

"List of Insects Collected in Arizona."
By Dr. F. H. Snow, of the University of Kansas, Lawrence.

"Preliminary List of Medicinal and Economic Plants in Kansas."
By B. B. Smyth, Topeka.

LOCO WEED.

By L. E. Sayre, University of Kansas, Lawrence.

Read before the Academy, at Topeka, January 1, 1903.

THE subject of loco is a good deal like a tradition—it grows in the memory and in the imagination. There are plenty of facts to encourage, and, on the other hand, there are plenty of facts from equally good and authentic sources to discourage, the faith that we have placed in *Astragalus mollissimus* as a poisonous plant. This plant, it is well known, is said to cause dementia, some believing that the secret lurking power of this innocent wild pea extends beyond the lower animal, even to the human family. Applying the theory of "*similia*," we have found those who claim that in some remote future time we may find in this plant a valuable remedy for the cure of insanity. Members of the Academy may remember some reports made a few years ago in which a chemical analysis of the weed was given. Concentrated preparations of the plant, representing the alkaloid, were made and administered both to the lower animals and to *one member* of the human family. All live to offer themselves for further investigation; they neither affirm nor approve the statement that loco is the "crazy weed."

We would not have any one think for a minute that we discredit the ground for the opinion that, in some mysterious way, certain disorders occur among cattle in connection with what is commonly called "loco weed." But the problem is, What is this connection? What relation has *Astragalus mollissimus* to the disease of such varied symptoms, sometimes called "locoism"? If we could assume that the loco, like clover and alfalfa—belonging, as it does, to the same family—should have similar properties as a nitrogenous food, then we might find a similarity between it and a distemper or disease not unlike the ordinary class of diseases brought about by a disturbance in the digestive tract, such as may be expected when an animal in a half-starved condition is permitted to overfeed on alfalfa or clover. This condition, if continued, could naturally lead to a disturbance of the nervous system, of which the brain is the center. Take, for example, a poorly fed horse or cow, such as is characterized by the range-fed cattle in winter. Let either be suddenly supplied with plants from the pea family, rich in legumin, and the natural result would be a disturbance in the digestive tract, which might assume all

sorts of pathological symptoms, among these the "locoism" so poorly defined by various reporters.

This theory of the inciting cause of loco disease has been suggested in a former paper, and the additional evidence which has come to us since seems to confirm this theory, even though statements suggesting other theories are not wanting. For example, from Guimon, Okla., Mr. Oscar Glandville, to whom, by the way, we are indebted for a splendid lot of the plant—root, stem, and leaves—we obtain the following information, accompanying the consignment of the plant. He says: "If you will examine closely the plant sent, you will see, under the leaves of the unhealthy branches, small eggs. When a cow or a horse swallows these eggs by eating the leaves, the eggs hatch out, and the larvæ, wriggling about, seem to affect the brain." This is the ranchman's hypothesis, and he proves it to you by showing the stomach of an animal dead from the loco habit. He also cites you the year when the loco is healthy—no eggs are to be found on the leaves, no boring in the roots. He says these are the years when cattle can eat it without injury. Loco weed will be found unhealthy in one pasture and very thrifty in another. The pastures where the unhealthy weed exists is the only place where the cattle can get locoed. The ranchmen claim that this insect kills the loco out completely every seven years by boring into the root. This year the loco has been more healthy than common; consequently less cattle have been lost.

Mr. John Fields, director of the experiment station at Stillwater, Okla., addressed a recent live-stock convention on "How best to prevent loco." He said: "One either believes that there is something in this loco business, or he believes that there is nothing in it." He indicated that he had no fixed opinion himself. Quoting from his own word: "Our present activity along this line dates from a request made by Senator Marum, of Woodward, who has been studying and watching the habits of the loco plant growing there. He observed an insect that seemed to be killing off the loco, and another insect that killed the first one, and it was his idea that, by furthering the propagation of the loco-destroying insect, it might be possible to eradicate loco at small cost. The idea, he said, is an entirely feasible one, and presents many attractive features. He suggested a possible relation between the loco-eating habit and abortion in cattle. This, he stated, deserves immediate attention."

Mr. Fields referred to some loco experiments conducted by Doctor Lewis, veterinarian. The plant was fed to rabbits, with the expectation of "locoing" them. The leaves, the stems, the whole plant and an extract of the plant were fed to different lots of rabbits for a period of one to two months, without noticeable effect. Mr. Fields added

that these experiments proved nothing, only that further work must be done on this line with cattle.

Quoting from Doctor Lewis, Mr. Fields said: "We consider loco one of the worst enemies to stock on the plains. It affects cattle and horses about the same, and unquestionably it will produce abortion. Our mares and cows will not do us any good so long as its effects remain in their systems. If they eat much of it and do not abort, their young are deformed in some way; in fact, worthless."

This phase of the physiological action of loco is a new one to us, and we think should be recorded. As to the question of larvæ and insects for which the plant serves as host, one of these, found commonly upon the flowers and other parts of the plant, is known as the pea weavil, *Brunchus aureolus*. It is mentioned in Insect Life, volume V, page 166. The other one is known as *Walshia amorphilla*. The grubs of these have been frequently received in Washington for examination (Insect Life, vol. II, p. 50), the sender always being of the impression that the worms were the cause of the peculiar effect upon the live stock. But the report upon these insects is as follows: "The maggots are harmless larvæ of a little moth, *Walshia amorphilla*, which occur also in allied plants, boring into roots and stems."

The old theory that an alkaloidal poison is secreted in the plant, causing the loco trouble, has not been found tenable. But, on searching for a poisonous alkaloid, it has been discovered that a very minute quantity can be extracted, and this, when administered in solution to kittens, would produce only temporary inconvenience of a local character. Perhaps one of the most careful pieces of chemical work upon the plant, with a view of isolating the poisonous principle, was that of Doctor Power and Mr. Cambier, of the University of Wisconsin. In these experiments, one kilogram of the herb yielded 0.2 gm. of an alkaloid, equivalent to 0.006 per cent. This alkaloid was not found to be especially active, as when 0.2 of a gram was fed to a kitten, a frothing at the mouth and a profuse flow of saliva continued for half an hour, after which the animal finally recovered. These symptoms not uncommonly accompany the administration of many of the saponinoid principles of plants which are comparatively harmless. We are strongly of the opinion that the so-called locoism cannot be produced by any preformed alkaloidal principle existing in the plant. What alkaloidal substances may be formed by disturbed digestion in the presence of this nitrogenous food in the digestive tract has been only a matter of conjecture.

We have evidence of cases where the loco disease was entirely stamped out by carefully caring for, wintering and feeding stock according to more modern methods. Mr. J. P. Cone, now living in

Seneca, Kan., stated that in 1886 he, with another farmer, bought 2 head of cattle in the latter part of March; in the spring they we anxious to put them out to grass. The cattle were poor and unde fed, and having a frail constitution—a characteristic of open-ran cattle; that is, cattle wholly dependent upon nature's supply for fo When these cattle were placed into pasture of grass interspersed wi loco they died off rapidly, a large percentage being lost. Mr. Co and his partner investigated the matter for themselves, and came the conclusion that the cause was due to the suddenness of food chan The following winter Mr. Cone states: "We put up feed for the w ter, and our herds came to grass with healthier constitutions, and did not lose another from loco weed, although it was as abundant it had been formerly." Prof. L. G. Carpenter, of Fort Collins, forms me that the loco plant has been collected and fed to horses some length of time, but a detailed report of these experiments not yet available. Other reports have come to us that if the anir is in prime condition no fear of the loco weed need be entertained.

We do not wish to be understood as believing that the question "locoism" has been settled by any theory we have advanced; on contrary, as time and means permit, we shall continue the investi tion, ready to follow up any suggestions which those who have h opportunities of observation have to offer. Some have suggested th the mysterious lurking power of the loco plant might be found in organic acid. Accordingly we have taken this up for investigati and have succeeded in isolating the acid of the plant. We are n able to report fully on physiological experiments with this acid as y but, so far as we have gone, it seems to be without toxic properti We have also had the suggestion that the harm coming from t plant is due to the inorganic constituents; this clue has been follow up, but, like the others, has brought us no nearer to the solution the problem.

Mr. Havenhill, assistant professor of pharmacy, finds the inorga constituents as follows: Acid in oven-dry herb, 19.9 per cent.; of th 5 per cent. is soluble in water. Ash in oven-dry root, 6.2 per cer of this, 33.5 per cent. is soluble in water. This shows the prepond ance of the alkalies to be in the root. The analysis does not indic a cause for any disorder or disease in connection with the plant.

We are now experimenting with the powdered leaves and stem connection with an artificially prepared gastric fluid. Possibly may find developed in appreciable quantity prussic acid. Such a action seems possible in the light of the experiments of H. B. Sle upon sorghum. (See Trans. Amer. Chem. Soc., vol. XXV, p. 55.)

Smoky Hill River Valley, showing Shale Banks.

NOTES ON TREES, SHRUBS AND VINES IN THE CHEROKEE NATION.

By CHARLES N. GOULD, of the University of Oklahoma, Norman, Okla.

Read before the Academy, at Iola, December 30, 1901.

THE area described in this article comprises the southeastern part of the Cherokee nation. In general, it is that part of the nation that lies between the Illinois river on the west, the Arkansas on the south, and the state of Arkansas on the east. Tahlequah, the capital of the nation, is in the northwestern part of the region, and Fort Smith, Ark., is near the southeastern corner. In other words, the region includes the Tahlequah quadrangle and the northern part of the Sallisaw quadrangle of the United States Geological Survey. The topography is in general quite broken. The western spurs of the Boston mountains extend into the northern part of the area. Some of the peaks are 800 or more feet above the level of the streams. The small creeks tributary to the Arkansas and Illinois have carved deep channels through these mountains. Precipitous bluffs and narrow cañons are common, while in general the valleys are narrow and tortuous. In the northern part of the region the rock on the lowlands is chiefly chert, while on the highest hills limestones and sandstones appear. To the south the chert runs out and sandstones and shales make up the greater part of the rock.

With the unimportant exception of a few patches of prairie near the Arkansas river, the entire area is heavily timbered. Over a large part of the country a person may ride all day and scarcely be out of the woods. In many parts of the region all the cleared land that one will encounter in the course of a day will consist of a few patches of a few acres each surrounding some Indian cabin.

A dweller on the plains will not soon forget the view, as seen from a tree-top on the summit of one of the high hills. Away and away, as far as vision can reach, extends a rolling sea of green. Hills and hollows, ridges and valleys, gentle slopes and sharp declivities, all are mantled with a wealth of foliage. Here and there, along a valley or on a level hilltop, may be seen a dot of yellow or brown, indicating the presence of a clearing among the timber. But clearings are rare, and in general the forest extends unbroken for scores of miles.

The oaks and hickories are by far the most abundant trees in the region. On the slopes and hilltops black-jacks and post-oaks are more

NOTE.—After page 144 had been printed two errors were discovered in it. In tenth line from bottom, read *Ash* for "Acid," and in second line from bottom read *H. B. Slade* for "H. B. Sledd."—L. E. S.

abundant than any other species. In fact, throughout the region, perhaps three-fourths of the trees belong to these two species. Black oaks and red oaks, however, are quite abundant on the highlands. Chestnut oaks are not so common. Chinquapins and white oaks are occasionally found, and near the streams water oaks and willow oaks.

There are also several species of hickory. The most common is probably the large shellbark and the common small hickory-nut. Shagbark hickory is found in the bottom lands along with the pecan and black walnut. Sweet gum flourishes near the streams and black gum, while seemingly confined to certain localities, grows equally well on high or low ground. The same statement may be made of ironwood. There are three elms—white, slippery and winged elm. Dogwood flourishes on the low ground along with the redbud and spice wood, although any of these trees may occasionally be found in moist or well-shaded places on the hills. The sycamore grows along the streams and the ash in thickets on the edge of the cleared land. Athwart the running streams the birch often hangs its graceful limbs. The two conifers in the region, pine and cedar, are usually found on rocky ledges or on high, rocky hills. Both hard and soft maples are often found on the rich bottom land along with the pawpaw and chinaberry. Locust and honey-locust are not uncommon.

The crab-apple, several species of plum and the hawthorn and red haw grow in clumps in the dense part of the forest. The hackberry often attains considerable size on the bottoms. The several species of willow and the elder also prefer the moist soil. Wild cherry, basswood, and witch-hazel are occasionally met with. The persimmon and two species of sumac thrive in deserted fields. Mulberry and box-elder, while not particularly common, are sometimes found on rich soil. Cottonwoods are occasionally found along the streams, and the button-bush peeps up from behind a creek bank. The buckeye is not rare in certain localities, and occasionally the service-berry is met with on sunny slopes. *Amorpha fruticosa* is sometimes found along creek banks.

Among climbers may be mentioned the greenbrier, trumpetflower, poison ivy, and half a dozen species of wild grapes, all of which grow rank along the streams. Virginia creeper is often found on dead trees. Blackberry, raspberry and dewberry vines are found in old clearings, and coral-berries, huckleberries and blueberries in the timber.

A PROVISIONAL LIST OF THE UREDINEÆ OF BOURBON COUNTY, KANSAS.

By A. O. Garrett, Salt Lake City, Utah.

Read (by title) before the Academy, at Topeka, January 1, 1903.

THE following list of rusts includes all species observed by the writer during seven years of residence in Bourbon county, all of which have been collected by him. I wish to thank Mr. Elam Bartholomew, of Rockport, Kan., and Prof. J. C. Arthur, of Purdue University, Lafayette, Ind., for the great assistance they have rendered in determination and citation, and for the many valuable suggestions received from them.

1. Æcidium grindeliæ Grif. (Bul. Torr. Bot. Club, vol. 29, p. 299, May, 1902.)
   On leaves of Grindelia squarrosa (Pursh) Dunal, May 29, 1902. New to the state.
2. Æcidium grossulariæ Schum.
   On leaves of Ribes sp., July 9, 1902.
3. Æcidium jamesianum Peck.
   On leaves of Asclepiodora viridis (Walt.) A. Gr., May 29, August 6, 1902.
4. Æcidium kellermani De Toni.
   On leaves, stems and pods of Baptisia australis (L.) R. Br., June 15, 1900.
   On leaves, stems and pods of Baptisia leucantha T. & G., June 21, 1902.
5. Æcidium peckii De Toni. (I of Puccinia peckii [DeT.] Kellerman.)
   On lower leaves of young plants of Onagra biennis (L.) Scop. (Œnothera biennis L.), May 24, 1902.
   On leaves of Hartmannia speciosa (Nutt.) Small (Œnothera speciosa Nutt.), May 25, 1902.
6. Æcidium pentstemonis Schw. (I of Puccinia andropogoni Schw.)
   On leaves of Penstemon digitalis (Sweet) Nutt., May 30, 1902.
7. Æcidium solidaginis Schw.
   On leaves of Solidago missouriensis Nutt., June 15, 1901.
8. Æcidium verbenicolum E. & K. (I of Puccinia vilfæ A. G. H.)
   On leaves of Verbena angustifolia Michx., June 15, 1901.
   On leaves of Verbena urticifolia L., June 15, 1901.
9. Æcidium xanthoxyli Peck.
   On blades and petioles of leaves of Xanthoxylum americanum Mill.
10. Coleosporium ipomœæ Schw.
    On leaves of Ipomœa pandurata (L.) Meyer, August 11, 1902. This is the first record of the collection of this rust in the state.
11. Coleosporium solidaginis (Schw.) Thum.
    On leaves of Solidago sp., Aug. 8, 1902.
12. Coleosporium vernoniæ B. C.
    On leaves of Vernonia baldwinii Torr., Aug. 18, 1900; July 31, 1902.

13. Gymnosporangium clavariæforme Jacq. I.

14. Gymnosporangium macropus Lk. III.
On Juniperus virginiana L., Apr. 11, 1902.

15. Melampsora farinosa (Pers.) Schroet.
On leaves of Salix fluviatilis Nutt., Nov. 10, 1901; Aug., 1902.
On leaves of Cratægus sp., Aug. 11, 1902.

16. Puccinia bartholomæi Diet. II.
On leaves of Bouteloua curtipendula Michx. (*B. racemosa Lag.*) Aug. 6, 1902.

17. Puccinia caricis-asteris Arth., I. (*Æcidium asterum Schw.*)
On leaves of Aster multiflorus Ait., May 29, 1902. See "Cultures of Uredineæ in 1900 and 1901," by J. C. Arthur, in Journal of Mycology, vol. 8, June, 1902.

18. Puccinia caricis-erigerontis Arth. I, III.
On leaves and stems of Erigeron ramosus Walt., June 15, 1901. I.
On leaves and stems of E. philadelphicus L., June 15, 1901. I.
On leaves and stems of E. annuus (L.) Pers., I, May 26, 1902.
On leaves and stems of Carex sp., III, Nov. 10, 1901.
Recent inoculation experiments made by Professor Arthur show that the æcidial stage of this rust is *Æcidium erigeronatum Schw.* (Jour. Myc., 8:53.)

19. Puccinia convolvuli (Pers.) Cast. II.
On leaves of Convolvulus sepium L., July 9, 1902. Quite destructive to its host.

20. Puccinia cyperi Arth. II.
On leaves of Cyperus strigosus L., July 31, 1900.

21. Puccinia helianthi Schw. I, II, III.
On leaves of Helianthus annuus L., I (*Æcidium compositarum helianthi Burrill*); and II, May 25, 1902.
On leaves of H. orgyalis D. C., I, II, III, July 7, 1902; and III, August 6, 1902.
On leaves of H. doronicoides Lam., II and III, October 26, 1901.

22. Puccinia heterospora B. & C. III.
On leaves of Abutilon abutilon (L.) Rusby (A. avicennæ Gært.), July 31, 1900.

23. Puccinia hieracii (Schum.) Mart. II.
On leaves of Taraxacum taraxacum (L.) Karst. (*T. officinale Weber*), June 27, 1902.

24. Puccinia nigrescens Peck. I, II, III.
On leaves and stems of Salvia pitcheri Torr. (S. azurea grandiflora Benth.) I and II, May 28, 1902; III, August 6, 1902.
The æcidial stage of this species has not been previously reported in America. Æcidia amphigenous, few, in irregular clusters; peridia low; æcidiospores elliptical, pale yellow, 28–24 x 16 mm. in diameter; wall thin, smooth.

25. Puccinia poarum Niessl. II. (*Puccinia graminis Pers.*)
On leaves of Poa pratensis L., July 10, 1902.

26. Puccinia podophylli Schw. I, III.
On leaves and stems of Podophyllum peltatum L., I and III, May 10, 1902; and III, May 27, 1902.
While collecting the æcidia on May 10, some of the plants of Podophyllum were pulled up, and it was observed that quite a few of them were infested with the sori of the teleutospores of the rust. In each case the sorus was between the rhizome and the surface of the ground. Underground sori were again found on the 27th.

27. Puccinia polygoni-amphibii Pers. II.
On leaves of Polygonum convolvulus L., August 11, 1902.

28. Puccinia rubigo-vera (D. C.) Wint. II, III.
On leaves of Hordeum jubatum L., May 29, 1902. II.
On leaves of Triticum vulgare II, May 28, 1902; on culms and leaves, III, August, 1902.

29. Puccinia silphii Schw. III.
On stem and leaves of Silphium integrifolium Michx., June 21, 1902.

30. Puccinia sorghi Schw. II.
On leaves of Zea mays, July, 1902.

31. Puccinia vernoniæ Schw. II, III.
On leaves of Vernonia baldwinii Torr. August 6, 1902.

32. Puccinia violæ (Schum.) D. C. I, II, III.
On leaves of Viola pubescens Ait., I, May 3, 1902; II, III, May 27, 1902.
On leaves of Viola cucullata Ait., II, III, May 29, 1902.

33. Puccinia windsoriæ (Schw.) I (Æcidium pteliæ B. & C.)
On leaves and rarely on fruits of Ptelia trifoliata L., June 15, 1901; June 21, 1902.
This rust is found especially abundant on the leaves of the very young shrubs, and is usually present wherever its host is.

34. Puccinia xanthii (Schw.) III.
On leaves of Ambrosia trifida L., July 15, 1902.
On leaves of Xanthium canadense Mill., July 31, 1902.

35. Pucciniastrum crotonis (Cke.) De Toni. I, II, III.
On leaves of Croton monanthogynus Michx., I, Aug. 18, 1900; II, III, Oct. 26, 1900.
On leaves of Croton capitatus Michx., I, Aug. 18, 1900; III, Oct. 26, 1900.

36. Uredo gaurina Peck.
On leaves and stems of Gaura biennis L., Aug. 6, 1902.

37. Uredo nitens (Schw.) De Toni.
On leaves of Rubus sp., May 3, 1902.

38. Uromyces astragali (Opiz.) Sacc. II.
On leaves of Astragalus carolinianus L. (*A. Canadensis L.*), Aug. 13, 1902. Sori very inconspicuous.

39. Uromyces caladii (Schw.) Farl. I, II, III.
On leaves of Arisæma dracontium (L.) Schott, I (*Æcidium caladii Schw.*), and II, May 5, 1902; and III, May 27, 1902.
On leaves of Arisæma triphyllum (L.) Torr., I, May 30, 1902; and III, May, 1901.

40. Uromyces euphorbiæ C. & P. I, II, III.
    On young leaves of Euphorbia dentata Michx., I, May 25, 1902; II, Ma 25 (on same plant with the aecidia), and Aug. 11, 1902.
    On leaves of Euphorbia sp., III, Aug. 11, 1902. See "Cultures of Ured neæ in 1900 and 1901," by J. C. Arthur, in Journal of Mycolog vol. 8, June, 1902.

41. Uromyces graminicola Burrill. III.
    On blades and culms of Panicum virgatum L., Nov. 10, 1901.

42. Uromyces hedysari-paniculata (Schw.) Farl. II, III.
    On leaves of Meibomia sessilifolia (Torr.) Kuntze (*Desmodium sessi folium T. & G.*), July 31, 1900.

43. Uromyces howei Peck. III.
    On leaves of Asclepiodora viridis (Walt.) A. Gray, Aug. 6, 1902.

44. Uromyces hyperici Schw. I.
    On leaves of Hypericum ellipticum Hook., June 15, 1901.

45. Uromyces spermacosis (Schw.) Curt. III.
    On leaves of Diodia teres Walt., Jan. 2, 1902.

STATISTICS ABOUT KANSAS BIRDS.

By D. E. LANTZ, Manhattan.

Read before the Academy, at Topeka, January 2, 1903.

SINCE the publication of my "Historical List of the Birds of Kansas," in volume XVI of our Transactions, there have been three additions to the list, all reported by Dr. R. Matthews, of Wichita. These additions are the Roseate Spoonbill, *Ajaja ajaja* (Linn.); the Black Duck, *Anas obscura* Gmel.; and the Old-squaw, *Clangula hyemalis* (Linn.) Specimens of all these are in the possession of residents of Wichita. These additions bring the number of species and varieties now credited to Kansas up to 354, a number greater than that usually found in an inland state.

Lists of the birds of many of the different states have been published. A comparison of these lists is of interest, since it shows a surprising variation in the number of birds credited to states that are similar as to location and physical conditions. Colorado and Wyoming lie side by side, are of nearly the same size, and have similarities of elevation. Yet the former is credited with 387 species and varieties of birds, while the latter has but 288. The difference is principally due to the large number of southern forms which extend into southern Colorado. The lists of both states were made with great care, and probably few forms were included for which there is not ample warrant in the existence of the skin or mounted bird.

A similar comparison of the lists of Kansas and Nebraska should show a preponderance of numbers for Kansas, on account of the Texan forms which extend into this state. But the actual number on the Nebraska list is 415, while Kansas has but 354. Some explanation of this difference ought to be found. This probably lies in the principle upon which the list is made up. The Nebraska list is made up from the local and state lists of a considerable number of observers, and includes all that these observers reported. Baird's citations in the Pacific Railroad Reports, volume 9, of specimens from Nebraska, refer to a time when Nebraska territory extended much beyond its present limits. Such citations as to Kansas would add a considerable number of forms to our list. But in every case of such citations I studied the itinerary of the expedition credited with the bird's capture, and if such capture occurred outside of Kansas it was rejected from our list. Then, too, there have been changes of nomenclature and new varieties created in the list of North American birds. Early observers reported birds which later researches show were va-

rieties of the species. It does not seem right that both species and variety should be kept upon the lists when only the variety is found.

The accompanying table of our Kansas birds shows the number of families represented, the total number of varieties belonging to each, those that are resident, summer resident, migratory, found regularly in winter, and those accidental to our fauna.

An analysis of the table will show that 62 + 125, or 187, species breed in the state. Deducting the two obsolete species, we have 185 that almost certainly breed in Kansas. Only 119 of these are common, and this is the number that would affect most largely the insect life of the state. Many of these birds are restricted in their range within the state, occurring only in the eastern or western or southern part, and therefore the number of species common in any one locality during the summer will be considerably less than 100.

In winter—November, December, January, and February—there are 42 + 20, or 62, species common in the state, but probably less than half this number in any given locality. This is during the lowest ebb of insect life, and consequently the food of these species, except the woodpeckers, must be largely grains and grass seeds, with the addition of a few wild fruits that persist, such as hackberries, moonseed, and ampelopsis.

The spring months—March, April, and May—bring a great abundance of insects, and the number of bird species becomes proportionally abundant. The common summer residents—seventy-seven strong—arrive, and the fifty-eight common migrants. These, added to the forty-two common residents, make the number of species then common, 167. Of course these are not all present at once in time or place; but the table will serve to show how much more abundant relatively are the birds during the spring.

The fall migration of birds is not nearly so well marked as that of spring; the birds do not linger with us so long. Once started for their winter haunts, they make long flights southward, traveling by day and night. Many species are not seen in our latitude in the fall, and their migration is unmarked, except, perhaps, by an occasional call in the night, carried from the upper air to the ear of the listening man or woman who has learned to recognize the bird voices, and can thus note the time of the flight,

BIRDS OF KANSAS.

No. and name of family.	Total No. of species.	Resident.		Summer resident.		Migratory.		Winter sojourner.		Accidental.		
		Common.	Rare.	Common.	Rare.	Common.	Rare.	Common.	Rare.	Winter.	Summer.	Fall and spring.
1. Podicipidæ—Grebes	4	....	....	1	....	1	1	....	....	1	....	....
2. Urinatoridæ—Loons	1	....	....	....	1	....	....	....	....	....	....	....
3. Laridæ—Gulls and Terns	10	....	....	....	1	5	3	....	....	....	....	1
4. Anhingidæ—Darters	1	....	....	....	....	....	....	....	....	....	1	....
5. Phalacrocoracidæ—Cormorants	2	....	....	....	....	1	....	....	....	....	....	1
6. Pelecanidæ—Pelicans	1	....	....	....	....	1	....	....	....	....	....	....
7. Fregatidæ—Man-o'-war birds	1	....	....	....	....	....	....	....	....	....	1	....
8. Anatidæ—Ducks and geese	33	....	....	....	8	12	8	1	1	2	....	1
9. Ibididæ—Ibises	2	....	....	....	....	....	1	....	....	....	1	....
10. Ciconiidæ—Storks and wood ibises	1	....	....	....	....	....	....	....	....	....	1	....
11. Ardeidæ—Herons, bitterns, etc	9	....	....	4	2	....	....	....	....	....	3	....
12. Gruidæ—Cranes	3	....	....	....	....	2	1	....	....	....	....	....
13. Rallidæ—Rails, etc	8	....	....	2	5	....	....	....	....	....	....	1
14. Phalaropodidæ—Phalaropes	2	....	....	....	1	....	1	....	....	....	....	....
15. Recurvirostridæ—Avocets, etc	2	....	....	....	2	....	....	....	....	....	....	....
16. Scolopacidæ—Snipes, sandpipers	25	....	....	2	2	11	9	....	....	....	1	....
17. Charadriidæ—Plovers	7	....	....	2	1	1	3	....	....	....	....	....
18. Tetraonidæ—Grouse, quail, etc	6	3	3	....	....	....	....	....	....	....	....	....
19. Phasianidæ—Pheasants, etc	1	1	....	....	....	....	....	....	....	....	....	....
20. Columbidæ—Pigeons	2	....	....	1	1	....	....	....	....	....	....	....
21. Cathartidæ—American vultures	2	....	....	1	1	....	....	....	....	....	....	....
22. Falconidæ—Hawks and eagles	24	7	6	2	1	1	....	2	3	1	1	....
23. Strigidæ—Barn owls	1	1	....	....	....	....	....	....	....	....	....	....
24. Bubonidæ—Horned owls	9	4	2	1	....	....	....	1	1	....	....	....
25. Psittacidæ—Parrots	1	1	....	....	....	....	....	....	....	....	....	....
26. Cuculidæ—Cuckoos, etc	3	....	....	2	....	....	....	....	....	....	1	....
27. Alcedinidæ—Kingfishers	1	....	....	1	....	....	....	....	....	....	....	....
28. Picidæ—Woodpeckers	10	5	1	1	....	....	2	....	....	....	1	....
29. Caprimulgidæ—Goatsuckers	6	4	2	....	....	....	....	....	....	....	....	....
30. Cypselidæ—Swifts	1	....	....	1	....	....	....	....	....	....	....	....
31. Trochilidæ—Humming-birds	1	....	....	....	1	....	....	....	....	....	....	....
32. Tyrannidæ—Tyrant flycatchers	12	....	....	8	4	....	....	....	....	....	....	....
33. Alaudidæ—Larks	3	2	....	....	....	....	....	1	....	....	....	....
34. Corvidæ—Crows, jays, etc	7	2	1	....	....	....	....	....	....	3	1	....
35. Icteridæ—Blackbirds, etc	12	2	....	6	2	1	....	....	1	....	....	....
36. Fringillidæ—Finches and sparrows	55	4	1	24	4	10	....	12	7	2	1	....
37. Hirundinidæ—Swallows	6	....	....	5	1	....	....	....	....	....	....	....
38. Ampelidæ—Waxwings	2	....	1	....	....	....	....	....	1	....	....	....
39. Laniidæ—Shrikes	3	....	....	1	....	....	....	1	....	....	1	....
40. Vireonidæ—Vireos	7	....	....	6	....	....	1	....	....	....	....	....
41. Mniotiltidæ—Wood-warblers	34	....	....	8	9	5	11	....	1	....	....	....
42. Motacillidæ—Wagtails	2	....	....	....	....	2	....	....	....	....	....	....
43. Troglodytidæ—Wrens	11	....	1	6	3	....	....	....	1	....	....	....
44. Certhiidæ—Creepers	1	....	....	....	....	....	....	1	....	....	....	....
45. Paridæ—Nuthatches and tits	5	4	....	....	....	....	1	....	....	....	....	....
46. Sylviidæ—Kinglets, etc	3	....	....	1	....	2	....	....	....	....	....	....
47. Turdidæ—Thrushes, etc	11	2	1	1	....	2	2	1	1	1	....	....
Totals	353	42	20	77	48	58	44	20	17	10	14	4

8. Summer resident species, common in migration.
19. Obsolete.
21. One nearly obsolete.
25. Obsolete.
38. The resident species common in winter.

NOTES ON THE BIRDS OF KANSAS, AND A REVISED CATALOGUE.

By FRANCIS H. SNOW, of the University of Kansas.

Read before the Academy, at Topeka, January 2, 1903.

WHEN the writer of this paper arrived at Lawrence, Kan., in the last week of August, 1866, about ten days before the opening of the State University, he took the earliest opportunity to call upon the chancellor of the University. He took it for granted that some preliminary arrangements would be necessary before the arrival of the important day which should usher into existence so important an institution as that with which he was to be connected as a member of its first faculty. The chancellor, the Rev. R. W. Oliver, rector of the Episcopal church of Lawrence, informed him that nothing could be done until the opening day, and advised him to "get a gun and go shooting." This advice was conscientiously followed, with the result that the writer soon became deeply interested in the birds of Kansas, and began to prepare a catalogue. He had the entire field to himself, there being no other person in the state for several years who was known to him as having an interest in ornithology. He soon organized among his students an enthusiastic class in zoology, and instituted an ornithological survey. It was a great delight to him to enumerate the birds of Douglas county, and to explore a field never before investigated with reference to its avifauna.

In April, 1872, he published the first edition of his Catalogue of the Birds of Kansas, in the *Kansas Educational Journal*. The list of birds in this catalogue included 239 species and varieties, of which thirty-two species were inserted on the authority of Dr. T. M. Brewer, of Boston, the eminent ornithologist.*

Mr. J. A. Allen, of the Museum of Comparative Zoology, at Cambrige, Mass., reviewed this list in the *American Naturalist* for May,

* The thirty-two species thus introduced upon Doctor Brewer's authority were the following: Sphyrapicus varius, Tyrannus verticalis, Contopus borealis, Empidonax flaviventris, Hylocichla fuscescens, Hylocichla swainsonii, Thryomanes bewickii, Regulus satrapa, Protonotaria citrea, Helminthophila celata, Helminthophila peregrina, Dendroica pennsylvanica, Dendroica dominica albilora, Wilsonia pusilla, Pinicola canadensis, Carpodacus purpureus, Spinus pinus, Loxia americana, Loxia leucoptera, Poospiza bilineata, Melospiza lincolni, Calamospiza melanocorys, Cyanospiza amœna, Scolecophagus ferrugineus, Corvus carnivorus, Charadrius dominicus, Phalaropus tricolor, Macrorhamphus scolopaceus, Tringa fuscicollis, Ereunetes pusillus, Symphemia semipalmata, and Cygnus buccinator. It is worthy of note that all these species reported by Doctor Brewer in 1872 as occurring in Kansas have been verified by subsequent captures, with the exception of the eight following: Empidonax flaviventris, Dendroica dominica albilora, Pinicola canadensis, Loxia americana, Loxia leucoptera, Poospiza bilineata, Thryomanes bewickii, and Hylocichla fuscescens.

1872, his chief criticism being that certain species known to him as occurring in Kansas were not included, and that five species were erroneously indicated as breeding in Kansas.

In the *American Naturalist* for August, 1872, Dr. T. M. Brewer expressed his obligations to the author of the list for not having included therein any "birds in regard to whose occurrence in the state he he had not positive evidence, and who had been able to resist the besetting temptation to swell his catalogue by mere guesswork, or by giving a redundant list of birds that 'probably would be' or 'ought to be found' within the prescribed limits." In the same number of the *American Naturalist* I published a list of forty-five additional species, of which number Mr. Allen contributed twenty-one species (all of which have been retained), Prof. S. F. Baird, the secretary of the Smithsonian Institution, twenty-three species,* and Mr. E. A. Popenoe, of Topeka (then a student of Washburn College), one species (*Coturniculus henslowi*).

In the meantime, in the June, 1872, number of the *Kansas Educational Journal*, I had published forty of the above-mentioned forty-five additions, and in Weston's Guide to the Kansas Pacific Railway, which appeared in July, 1872, a pamphlet of 204 pages, I had published an amended Catalogue of the Birds of Kansas, containing 277 species and varieties. No "separates" of this catalogue were obtained. This was in reality my second edition.

In October, 1872, I issued a third edition, commonly known as the "second edition," and containing 282 species and varieties.

In 1875 I contributed to the Kansas Academy of Science a third (in reality the fourth) edition, which was published in separate form, and was complete to January 1, 1876. It enumerated 302 species and varieties (295 species and 7 varieties), of which 137 were marked as breeding in Kansas. It omitted four species of the second edition, viz.: *Contopus richardsonii*, *Empidonax pusillus*, *Passerculus alaudinus*, and *Sterna hirundo*. The latter species was omitted from the fear of its having been confused with *Sterna forsteri*; *Contopus richardsonii* and *Empidonax pusillus* were omitted from fear of incorrect determination; and *Passerculus alaudinus* was omitted, not from any doubt of its occurrence in Kansas, but because Doctor Coues,

*The twenty-three species contributed by Professor Baird were as follows: Hypotriorchis richardsonii, Ictinia mississippienis, Milvulus forficatus, Turdus pallasii, Helminthophila chrysoptera, Seiurus noveboracensis, Dendroica cærulescens, Dendroica virens, Piranga æstiva, Vireo noveboracensis, Vireo solitarius, Troglodytes hyemalis, Sitta canadensis, Plectrophanes pictus, Plectrophanes melanomus, Ægialitis meloda, Squatarola helvetica, Actodramus bairdii, Limosa hudsonica, Numenius hudsonicus, Gallinula galeata, Bernicla hutchinsii, and Merganser serrator. All of these additions of Professor Baird have been confirmed by subsequent captures, except the six following: Helminthophila chrysoptera, Dendroica virens, Ægialitis meloda, Charadrius squatarola, Numenius hudsonicus, and Merganser serrator.

in his Birds of the Northwest, made this form synonymous with *Passerculus savanna*. Three of these four species, however, were subsequently restored to the list by Colonel Goss.

With the exception of a reprint of my third edition in Fourth Annual Report, Kansas State Board of Agriculture, 1875 (which appeared early in 1876), I published no additional complete list of the birds of Kansas, having left the formal continuance of this work to my friend, Col. N. S. Goss, so long as he lived. I, however, contributed to the *Observer of Nature*, a publication of the Natural History Society of the University of Kansas, to the Transactions of the Kansas Academy of Science, to the *Auk*, and to the Bulletin of the Nuttall Ornithological Club, the following ten species and one variety: *Neocorys spraguei*, *Melanerpes torquatus*, *Nyctiardea violacea*, *Plegadis guarauna*, *Xema sabinei*, *Passer domesticus*, *Icteria virens* var. *longicauda*, *Anhinga anhinga*, *Æchmophorus occidentalis*, *Picicorvus columbianus*, and *Somateria v-nigra*.

Thus, all together, the author of this paper, during the last third of the nineteenth century, had catalogued 305 species and 9 varieties of Kansas birds, or a total of 314 numbers or entries.

Up to the year 1878 no other citizen of Kansas had published any facts regarding the birds of Kansas. In that year Col. N. S. Goss began his notes upon this subject in an article on the "Breeding of the Duck Hawk in Trees," in the Bulletin of the Nuttall Ornithological Club. On July 25, 1879, he wrote me that he had in his collection 154 species of Kansas birds, of which he sent me a full list. In the same year he made his first addition to the list of Kansas birds—Bonaparte's Gull—as recorded in the publication just cited. He continued to increase our knowledge of the bird fauna of Kansas until he had added thirty-one species and races to the list.* The first edition of his Catalogue of the Birds of Kansas, published in 1883, contains 320 species and varieties. This catalogue omitted six species contained in my third edition, namely: *Helminthophaga chrysoptera*, *Dendroica cærulescens*, *Gallinula galeata*, *Ægialitis melodus*, *Poospiza bilineata*, *Empidonax flaviventris*. These omitted species had been included in my own catalogues on the authority of Professor Baird and Doctor Brewer as having been actually taken in

*The thirty-one species added to the Kansas Catalogue by Colonel Goss are the following: Larus californicus, Larus philadelphia, Fregata aquita, Anas fulvigula maculosa, Querquedula cyanoptera, Tantalus loculator, Grus canadensis, Porzana noveboracensis, Porzana jamaicensis, Phalaropus lobatus, Tringa alpina pacifica, Ægialitis nivosa, Colinus virginianus texanus, Tympanuchus pallidicinctus, Buteo borealis kriderii, Bubo virginianus subarcticus, Sphyrapicus varius nuchalis, Phænoptilus nuttalli nitidus, Contopus richardsonii, Otocoris alpestris arenicola, Ammodramus sandwichensis alaudinus, Ammodramus caudacutus nelsoni, Zonotrichia leucophrys intermedia, Cyanospiza ciris, Vireo atricapillus, Dendroica auduboni, Dendroica vigorsi, Wilsonia canadensis, Anthus spraguei, Hylocichla alicise, and Merula migratoria propinqua.

Kansas. Two of these six species have been verified by subsequent captures and the others may be similarly verified. Their retention in the list of Kansas birds at that time was authorized by the excellence of the authorities upon whose statement of actual captures they were originally introduced. In 1886 Colonel Goss published his Revised Catalogue of the Birds of Kansas, containing 335 species and races, of which 175 were characterized as breeding in Kansas.

Thus, up to the year 1899, six catalogues of the birds of Kansas had been published—four by the author of this paper and two by Col. N. S. Goss.

In June, 1899, there appeared in the Transactions of the Kansas Academy of Science, volume XVI, a "Review of Kansas Ornithology," by Prof. D. E. Lantz, of Manhattan. This review comprises two sections: First, "The Bibliography of Kansas Birds"; second, "An Historical List of Kansas Birds." In regard to the first section of this review, I make the following remarks:

1. There is much uncertainty, and necessarily a good deal of "guesswork," in regard to the determination of species and the locality of their occurrence, in the case of most of the species named by Professor Lantz as having been recorded to occur in Kansas up to and including William Kelley's publication, in 1851, entitled "An Excursion to California over the Prairies and Rocky Mountains and the Great Sierra Nevada, with a stroll through the diggings and ranches of that country." During the entire period of nearly fifty years included in this section of the "bibliography," there was no state of Kansas or territory of Kansas as yet set aside from the national domain. And yet Professor Lantz states that Pike entered "*Kansas*" in 1806. He also states that "no ornithological records of his trip were made, except that his hunters brought in turkeys." On this meager basis, Professor Lantz, in what purports to be a scientific paper, awards to Maj. Z. M. Pike the credit of first publishing a record of *Meleagris gallopavo* in Kansas.

2. In writing of my own Catalogue of the Birds of Kansas, first edition, 1872, Professor Lantz characterizes the *Kansas Educational Journal*, in which that catalogue appeared, as "a newspaper." It was not a newspaper, but a monthly educational journal.

3. He characterizes my catalogue as "a *defective* list of 239 species." A critical examination of this list reveals the fact that all but three of the 239 species are included in Professor Lantz's own "Historical List of Kansas Birds." The three not included are *Centrocercus urophasianus*, *Poospiza bilineata*, and *Empidonax flaviventris*. The defect of including the Sage Cock also applies to Goss's list of 1883; the

other two species omitted from the list of Professor Lantz were introduced on the most excellent authority of Dr. T. M. Brewer.

4. I note the omission from the "Bibliography of Kansas Birds," (1) of a list of forty additions to the Catalogue of the Birds of Kansas in the June, 1872, number of the *Kansas Educational Journal;* (2) "The Relation of Birds to Horticulture," an address delivered by the author of this paper at the tenth annual meeting of the Kansas State Horticultural Society, at Emporia, and published in volume XI of the transactions of that society, pages 65–75.

5. In reviewing the second edition of my Catalogue of the Birds of Kansas, October, 1872, Professor Lantz erroneously names *Larus argentatus smithsonianus* as a first record, whereas that species was given in my first edition. He also states that of the 282 species and races on the list only 270 are valid. Eleven of the twelve species thus declared not valid (I have not been able to find the twelfth) are as follows: *Colaptes hybridus* (which occurs abundantly all over Kansas), *Contopus richardsonii, Empidonax flaviventris, Helminthophaga chrysoptera, Eremophila cornuta, Poospiza bilineata, Numenius borealis, Porzana jamaicensis, Anas obscura, Sterna wilsoni, Tringa alpina.* It is pleasing to note that six of the species thus rejected as not "valid" have been restored in Professor Lantz's list, and have, therefore, in his judgment, become valid. Of the rejected species, *Anas obscura*, the Black Duck, is certainly valid, for I shot a specimen of it in 1871 and fully identified the species. *Eremophila cornuta* is valid, for it appears under a different name in Professor Lantz's list; and *Helminthophaga chrysoptera*, introduced upon Professor Baird's authority, ought to be valid, from the high standing of the authority elsewhere recognized by Professor Lantz. The inclusion of three not "valid" species, *Numenius borealis, Porzana jamaicensis*, and *Tringa alpina*, was due to errors of Mr. J. A. Allen, rather than of myself, as Professor Lantz himself has stated.

6. In noticing my list of additions to the Catalogue of Kansas Birds, published in the Transactions of the Kansas Academy of Science, volume VI, page 38, Professor Lantz omits the English Sparrow, of which I gave the first published record, and which is most certainly a very ubiquitous Kansas bird.

7. In commenting upon Col. N. S. Goss's Catalogue of the Birds of Kansas, first edition, 1883, Professor Lantz omits to mention his first record in that catalogue of *Querquedula cyanoptera.*

In reference to the second section of Professor Lantz's Review of Kansas Ornithology, entitled "An Historical List of the Birds of Kansas," I make the following comments:

1. In regard to *Anas obscura*—the Black Duck—Professor Lantz refuses to admit it to his list, stating that "evidence of its occurrence is entirely wanting and it should be dropped from our list." I consider this statement as an unwarranted imputation upon the ornithological ability of the professor of natural history in the University of Kansas, who personally identified this species, as above stated. And yet Professor Lantz gives credit to Lieutenant Abert for "first record" of *Sayornis phœbe*, from his mention of a "gray bird" and his description of its nest, and allows other "first records" upon evidence equally unscientific.

2. Professor Lantz gives "Snow, 1872, on authority of Baird," first record for *Branta canadensis hutchinsii*, (No. 48.) He does not state that in my third edition, 1875, this bird was given on my own authority, a specimen having been taken April 3, 1873, at Lawrence, by Nelson J. Stephens, a student in my class in zoology.

3. In regard to *Plegadis guarauna*, (No. 52,) first record should have been given to me, as I reported it to the Kansas Academy of Science at the thirteenth annual meeting, at Topeka, November 12, 1880, in a paper entitled "The Last New Kansas Bird." An account of the capture of this bird, which was skinned by me and has been for more than twenty years a mounted specimen in the museum of the University of Kansas, was given in the Lawrence newspapers at the time.

4. How does Professor Lantz know that the Sandhill Crane, (No. 65,) whose first record is by him credited to Gregg, 1844, was not the Little Brown Crane, *Grus canadensis?*

5. *Gallinula galeata*, the Florida Gallinule, (No. 72,) is credited to me "on authority of Baird." If Professor Lantz had consulted me, he could have included this species upon my own authority, as I took a specimen on Hackberry creek, in Gove county, Kansas, June 14, 1878. (See Trans. Kan. Acad. Sci., vol. X., p. 30, for a published record of this fact.)

6. *Himantopus mexicanus*, (No. 77.) This species, reported as "seen," is not entitled to admission to a list based upon actual captures.

7. *Macrorhamphus scolopaceus*, (No. 80,) is credited to me on authority of Brewer. It was given in my third edition, 1875, on my own authority, a specimen having been taken at Lawrence by my student, William Osburn, October 3, 1871, and another by student Bion H. Barnett, April 19, 1873.

8. Professor Lantz places an interrogation point after the citation of *Tringa canutus*, (No. 82,) as given in my catalogue of 1872. There can be no question about the authenticity of this record, as I

have in my collection of skins a specimen of this species taken by my student, Wm. E. Moore, at the Lawrence lake, April 17, 1871.

9. *Tringa bairdii*, (No. 85,) is credited to me in "1872, on authority of Baird." In my third edition, 1875, this species is given on my own authority. Two specimens were shot by myself at the Lawrence lake, October 26, 1872, one along the Wakarusa river, April 18, 1873, by student Frank Morgan, two along the Kansas river, April 11, 1874, by student B. H. Barnett, and another in the same locality by myself, April 17, 1874. These six specimens are in my collection of bird skins, Nos. 188, 189, 203, 328, 329, and 330.

10. *Limosa hæmastica*, (No. 91,) credited to me in 1872, on authority of Baird, was given in my third edition, 1875, on my own authority, two specimens, a male and a female, having been taken at the Lawrence lake, by student B. H. Barnett, April 19, 1873. They are in my collection of bird skins, Nos. 201 and 202.

11. How can Professor Lantz be at all certain that "an upland land snipe," mentioned by Wm. Kelley as having been seen during his "excursion to California, etc.," was *Bartramia longicauda*, (No. 96)? Such an instance of guesswork can have no scientific value.

12. *Numenius borealis*, (No. 101,) credited to Benson, 1874, for "first record," was recorded by me as taken at Lawrence by my student, Nelson J. Stephens, May 6, 1873. Its skin is No. 217 of my collection, with a complete series of measurements. I claim this as the first authentic record for this species.

13. Professor Lantz acknowledges that the "quail" mentioned by Say, 1823, may not have been *Colinus virginianus*, (No. 109,) and it is extremely probable that the same is true of the quail referred to by Maximilian and Parkman. I claim the first authentic record for this species.

14. The same uncertainty exists concerning the identity of Say's *Tympanuchus americanus*, (No. 305,) which may have been either of the two following numbers of Professor Lantz's list.

15. Professor Lantz should have quoted my third edition, 1875, in which *Ictinia mississippiensis*, (No. 121,) was given, not upon the authority of Baird, but upon my own authority, from material furnished by Prof. M. V. B. Knox, of Baker University, and Col. N. S. Goss.

16. It would have been an interesting fact for Professor Lantz to record in reference to Harlan's Hawk, *Buteo borealis harlani*, (No. 129,) that the male specimen of this species shot at Lawrence, in October, 1871, by my student, Nelson J. Stephens, is the most valuable ornithological specimen in the state, being the male type of the

species. (See full description of this specimen in Baird, Brewer and Ridgway's A History of North American Birds—Land Birds, volume III, page 293.) It is No. 192 of my collection of bird skins. This fact, if known to Professor Lantz, might have induced him to place Lawrence before Manhattan, where it chronologically belongs, in naming the localities for the capture of this hawk.

17. Professor Lantz omits to use my statement regarding *Archibuteo ferrugineus*, in the *Observer of Nature* for June 4, 1875, where Dr. Louis Watson is quoted as having captured two specimens of this species in the fall of 1874, and as having found it breeding in May, 1875. The specimens are Nos. 479 and 480 of my collection of skins.

18. *Falco richardsonii*, (No. 141,) is credited to "Snow, 1872, on the authority of Baird." This species was in my third edition, 1875, on my own authority. I have twelve specimens in my skin collection, prepared by my own hands from fresh material received from Dr. Louis Watson, the captures having been made on nine different dates, from October 6 to November 9, 1875, and a thirteenth specimen, taken at Lawrence, October 27, 1875, by my student, Wm. H. Challis, No. 600 of my collection. I have in my note-book a full record of the measurements of these thirteen birds, taken before skinning.

19. I do not recognize *Geococcyx californicus*, the Road-runner, as a Kansas bird, and I cannot comprehend how Professor Lantz can admit the inadequate evidence of its having been "seen" in southwest Kansas, and yet reject *Anas obscura* upon my own statement of personal capture and identification.

20. *Sphyrapicus varius*, (No. 161,) is credited to "Snow, 1872, on authority of Baird." It is given in my third edition, 1875, on my own authority, from a capture made by E. A. Popenoe, of Topeka.

21. *Tyrannus verticalis*, (No. 178,) is credited to "Snow, in 1872, on authority of Brewer." It was given in my third edition, 1875, on my own authority, from three specimens received from Doctor Watson, of Ellis, which are Nos. 508, 509 and 511 of my collection of skins.

22. *Contopus borealis*, (No. 182,) credited to "Snow, 1872, on authority of Brewer," was given in my third edition, 1875, on my own authority, from fresh specimens received from Doctor Watson, of Ellis, May 22 and September 14, 1875. The skins are Nos. 502 and 542 of my skin collection.

23. *Otocoris alpestris leucolema*, (No. 188,) was included in Colonel Goss's first catalogue, 1883, but was omitted from his revised catalogue. It would have been impartial treatment of Colonel Goss and myself if Professor Lantz had remarked in this case, as in the case of

Contopus richardsonii, (No. 184): "This species was included in Goss's first edition, but evidently upon insufficient evidence, for it was omitted from the second edition."

24. *Picicorvus columbianus*, (No. 196.) I claim the first authentic record for this species. Mr. L. L. Jewell, of Irving, Kan., in August, 1888, sent me for identification the wings and tail of a specimen taken in Marshall county by Mr. Charles Metz. I identified the species, and subsequently reported to Colonel Goss this interesting addition to our avifauna. It seems that Mr. Jewell at a later date sent a portion of the skin of the same specimen to Colonel Goss, as recorded in his History of the Birds of Kansas, page 386.

25. *Icterus bullocki*, Bullock's Oriole, (No. 206.) In his remarks concerning this species, Professor Lantz reaches the maximum of injustice towards the author of the present paper. He incorrectly states that I included this species in my third edition on the authority of Dr. S. W. Williston, but did not so credit it. The fact is that I included it in all four of my editions, upon my own authority, from two specimens taken by my own students, working under my own direction. The first of these specimens was taken in the timber along the Wakarusa river, four miles south of Lawrence, by student Geo. F. Gaumer, May 16, 1871. It was a young male, and is No. 136 of my collection of skins. The second specimen was a female, taken in the same locality, five days later, May 21, 1871, by student Charles Kennedy, and is No. 137 of my skin collection. And yet Professor Lantz states that "the entire lack of authentic specimens taken in the state had made Colonel Goss and others reluctant to include this bird in catalogues." Why, then, did he graciously "permit Snow, 1872, to stand"?

26. *Scolecophagus carolinus*, (No. 207,) is credited to "Snow, 1872, on authority of Doctor Brewer." In my third edition, 1875, it was inserted on my own authority, from a specimen taken by Dr. Louis Watson, at Ellis, October 29, 1875. The skin is No. 607 of my collection.

27. *Scolecophagus cyanocephalus*, (No. 208,) is credited to "Snow, 1872, on authority of Doctor Brewer." It was in my third edition, 1875, on my own authority, from five specimens taken at Ellis by Doctor Watson, September 18, 23, and 25, 1875. Their skins are Nos. 545, 546, 547, 548 and 573 of my collection.

28. *Carpodacus purpureus*, (No. 212,) is credited to "Snow, 1872, on authority of Doctor Brewer." It was in my third edition, 1875, on my own authority, a male specimen having been taken in the timber along the Kansas river, April 17, 1874, by my student, Bion H. Barnett. It is No. 343 of my collection of Kansas bird skins.

29. *Ammodramus sandwichensis alaudinus*, (No. 227,) should have been credited to "Snow, 1872," it having appeared in both my first and second editions. It was omitted from my third edition, 1875, as already stated, because Doctor Coues, in his Birds of the Northwest, made this form synonymous with the preceding, (No. 226.)

30. *Guiraca cærulea*, (No. 256,) should have been credited to "Snow, 1875," on his own authority. The five unskinned specimens were sent to me for determination by Doctor Watson, and their skins are Nos. 492, 498, 512, 513 and 514 of my collection. They were taken at Ellis on May 17, 22, and 26, and August 3, 1875.

31. Why does Professor Lantz includes in his list *Cynospiza amœna*, (No. 258,) and omit *Poospiza bilineata*, both species having been included in "Snow, 1872, on the authority of Doctor Brewer"?

32. *Piranga rubra*, (No. 264,) is credited to "Snow, 1872, on authority of Baird." It is in my third edition, 1875, on my own authority, a specimen having been taken along the Wakarusa river, near Lawrence, by my student, Geo. F. Gaumer, May 16, 1871, (No. 139 of my skin collection,) and another specimen taken at Lawrence, in the grove on the east flank of Mount Oread, by the hired man of Mr. H. W. Baker, (No. 474 of my collection of skins.)

33. *Hirundo erythrogaster*, (No. 267,) is credited to "Snow, 1872, on authority of Brewer." It was in my third edition, 1875, on my own authority, from a specimen sent me from Ellis, May 26, 1875, by Dr. Louis Watson, (No. 509 of my skin collection.)

34. Professor Lantz says of *Lanius ludovicianus*, (No. 274,) that the only record for Kansas is "Snow, 1872, who says: 'Several typical specimens of this southern form have been taken.'" What I did say in my 1872 editions was that "three specimens were taken in January and February, 1871." I have the following specimens of this species in my collection of bird skins: No. 11, taken in the Wakarusa timber, February 1, 1871, by my student, Jno. M. Walker; No. 12, taken at Lawrence, March 18, 1871, by student N. J. Stephens; No. 64, taken in Kanwaka, near Lawrence, March 16, 1871, by student Walter Pearson; Nos. 282 and 283, taken along the Wakarusa, by student K. D. Protzman, March 7 and 18, 1874; and No. 448, taken by student Geo. F. Gaumer in the same locality, April 1, 1875.

35. *Helminthophila celata*, (No. 288,) is erroneously given as "Snow, 1872, on authority of Brewer." The record of the occurrence of this species in Kansas was on my own authority, from a specimen taken in Wakarusa township by my student, Nelson J. Stephens, April 30, 1872. It was the breeding record which was given on the authority of Doctor Brewer.

36. *Dendroica pennsylvanica*, (No. 297,) is credited to "Snow, 1872, on authority of Brewer." It was in my third edition, 1875, on my own authority, from a specimen taken along the Wakarusa river, April 30, 1873, by student Geo. F. Gaumer. It is No. 209 of my collection of Kansas bird skins.

37. *Wilsonia pusilla*, (No. 314,) is credited to "Snow, 1872, on authority of Brewer." It was in my third edition, 1875, on my own authority, from a specimen taken in Wakarusa township, near Lawrence, May 17, 1873, by student N. J. Stephens, which is No. 245 of my skin collection, and another specimen taken by Dr. Louis Watson, at Ellis, September 30, 1875, which is No. 567 of my collection.

38. *Anthus spraguei*, (No. 318,) credited to Goss for first record, should have been credited to me, as I published it in Transactions Kansas Academy Science, volume VI, page 38, as an addition to my catalogue, a specimen taken at Ellis in November, 1877, having been sent me by Doctor Watson.

39. *Parus atricapillus*, (No. 334,) entered without historical credit, should have been assigned to "Snow, 1872."

40. *Regulus satrapa*, (No. 336,) credited to "Snow, 1892," should have been "Snow, 1872."

In conclusion, I present the following

TWENTIETH CENTURY EDITION
OF MY
CATALOGUE OF THE BIRDS OF KANSAS.

In this, my fifth edition, I have omitted all species whose occurrence in Kansas cannot be verified by actual captures since the opening of the University of Kansas, in September, 1866. *

I.—Family PODICIPIDÆ. Grebes.

1. Æchmophorus occidentalis Lawr. Western Grebe. Accidental.
2. Colymbus auritus Linn. Horned Grebe. Migratory; rare.
3. Colymbus nigricollis californicus Heerm. American Eared Grebe. Migratory.
4. Podilymbus podiceps Linn. Pied-billed Grebe. A rare summer resident; an abundant migrant.

*Fourteen species have thus been omitted, these species having been inserted in my first and second editions, 1872, on the authority of Dr. T. M. Brewer and Prof. Spencer F. Baird, communicated to me in personal letters. Although no manuscript authority could be more decisive than was thus secured for the insertion of these species, inasmuch as thirty years have now elapsed during which no specimens of them have been taken in Kansas, I prefer to exclude them from this Revised Catalogue. The omitted species are the following: Merganser serrator (the Red-breasted Merganser), Numenius hudsonicus (the Hudsonian Curlew), Charadrius squatarola (the Black-bellied Plover), Ægialitis meloda circumcincta (the Belted Piping Plover), Empidonax flaviventris (the Yellow-bellied Flycatcher), Pinicola canadensis (the Pine Grosbeak), Poospiza bilineata (the Black-throated Finch), Loxia curvirostra minor (the American Crossbill), Loxia leucoptera (the White-winged Crossbill), Helminthophila chrysoptera (the Golden-winged Warbler), Dendroica dominica albilora (the Sycamore Warbler), Dendroica virens, (the Black-throated Green Warbler), Thryomanes bewickii (Bewick's Wren), and Hylocichla fuscescens (Wilson's Thrush).

II.—Family URINATORIDÆ. Loons.

5. Urinator imber Gunn. Loon. Migratory; rare.

III.—Family LARIDÆ. Gulls and Terns.

6. Larus argentatus smithsonianus Coues. Migratory; rare.
7. Larus californicus Lawr. California Gull. Accidental.
8. Larus delawarensis Ord. Ring-billed Gull. Migratory; frequent.
9. Larus franklinii Sw. & Rich. Franklin's Gull. Migratory.
10. Larus philadelphia Ord. Bonaparte's Gull. Migratory; rare.
11. Xema sabinii Sab. Sabine's Gull. Accidental.
12. Sterna forsteri Nutt. Forster's Tern. Migratory; common.
13. Sterna hirundo Linn. Common Tern. Migratory; rare.
14. Sterna antillarum Less. Least Tern. Summer resident; rare.
15. Hydrochelidon nigra surinamensis Gmel. Black Tern. A rare summer resident; common in migration.

IV.—Family ANHINGIDÆ. Darters.

16. Anhinga anhinga Linn. Anhinga; Snake-bird. Accidental.

V.—Family PHALACROCORACIDÆ. Cormorants.

17. Phalacrocorax dilophus Sw. & Rich. Double-crested Cormorant. Migratory; rather common.
18. Phalacrocorax mexicanus Brandt. Mexican Cormorant. Accidental.

VI.—Family PELECANIDÆ. Pelicans.

19. Pelecanus erythrorhynchus Gmel. American White Pelican. Migratory; common.

VII.—Family FREGATIDÆ. Man-o'-war Birds.

20. Fregata aquila Linn. Man-o'war Bird. Accidental.

VIII.—Family ANATIDÆ. Ducks, Geese, and Swans.

21. Merganser americanus Cass. American Merganser. Winter sojourner; not uncommon.
22. Lophodytes cucullatus Linn. Hooded Merganser. A rare resident; a common migrant.
23. Anas boschas Linn. Mallard. A rare resident; abundant in migration.
24. Anas obscura Gmel. Black Duck. Migratory; very rare.
25. Anas fulvigula maculosa Senn. Mottled Duck. Migratory; rare.
26. Chaulelasmus streperus Linn. Gadwall. A rare summer resident; a common migrant.
27. Mareca americana Gmel. Baldpate. A rare summer resident; a common migrant.
28. Nettion carolinensis Gmel. Green-winged Teal. An abundant migrant; an occasional winter sojourner.
29. Querquedula discors Linn. Blue-winged Teal. An occasional summer resident; abundant in migration.
30. Querquedula cyanoptera Vieill. Cinnamon Teal. Migratory; rare.
31. Spatula clypeata Linn. Shoveler. A rare summer resident; a common migrant.
32. Dafila acuta Linn. Pintail. Migratory; common.
33. Aix sponsa Linn. Wood Duck. Summer resident; not uncommon.

34. Aythya americana Eyt. Red-head. Migratory; common.
35. Aythya vallisneria Wils. Canvas-back. Migratory; usually common.
36. Aythya marila Linn. American Scaup Duck. Migratory; rare.
37. Aythya affinis Eyt. Lesser Scaup Duck. Migratory; not common.
38. Aythya collaris Donov. Ring-necked Duck. Migratory; common.
39. Clangula hyemalis Linn. Old Squaw. Migratory; very rare. This species is new to our fauna. Its capture was communicated to me by my friend, Dr. R. Matthews, of Wichita. The specimen is in his collection. It was captured by Dr. J. W. Shultz, in November, 1901, on Patterson lake, in the south end of Harvey county. Mr. Gerald Volk, of Wichita, has another specimen taken March 1, 1902, at Gantz's mill, in Pratt county. Both these birds were alone when shot. Both "came in with a whiz and struck the water with such force as to attract attention."
40. Clangula americana Bonap. American Golden-eye. Migratory; rare.
41. Charitonetta albeola Linn. Buffle-head. Migratory; common.
42. Oidemia perspicillata Linn. Surf Scoter. Accidental. Added to the list in 1888 by A. L. Bennett.
43. Somateria v-nigra Gray. Pacific Eider. Accidental.
44. Erismatura rubida Wils. Ruddy Duck. A rare summer resident; a common migrant.
45. Chen hyperborea Pall. Lesser Snow Goose. Migratory; common.
46. Chen cærulescens Linn. Blue Goose. Migratory; rare.
47. Anser albifrons gambeli Hartl. American White-fronted Goose. Migratory; common.
48. Branta canadensis Linn. Canada Goose. Migratory; common.
49. Branta canadensis hutchinsii Sw. & Rich. Hutchins's Goose. Migratory; common.
50. Branta bernicla Linn. Brant. Migratory; very rare.
51. Olor columbianus Ord. Whistling Swan. Migratory; rare.
52. Olor buccinator Rich. Trumpeter Swan. Migratory; not uncommon.

IX.—Family Plataleidæ. Spoonbills.

53. Ajaja ajaja Linn. Roseate Spoonbill. Accidental. This species is new to the Kansas Catalogue. It was communicated to me by Dr. R. Matthews, of Wichita, who wrote me, September 26, 1899, that a male specimen was captured March 20, 1899, on Four-mile creek, near Douglass, in Butler county. It became the property of Mr. Gerald Volk, of Wichita.

X.—Family Ibididæ. Ibises.

54. Plegadis guarauna Linn. White-faced Glossy Ibis. Migratory.

XI.—Family Ciconiidæ. Wood Ibises.

55. Tantalus loculator Linn. Wood Ibis. Accidental.

XII.—Family Ardeidæ. Herons, Bitterns, etc.

56. Botaurus lentiginosus Montag. American Bittern. Summer resident; common.
57. Ardetta exilis Gmel. Least Bittern. Summer resident; not common.
58. Ardea herodias Linn. Great Blue Heron. Summer resident; common.
59. Ardea egretta Gmel. American Egret. Summer visitant; not uncommon.
60. Ardea candidissima Gmel. Snowy Heron. Summer visitant; occasional.
61. Ardea cærulea Linn. Little Blue Heron. Summer visitant; rare.

62. Ardea virescens Linn. Green Heron. Summer resident; common.
63. Nycticorax nycticorax nævius Bodd. Black-crowned Night Heron. A rare summer resident.
64. Nycticorax violaceus Linn. Yellow-crowned Night Heron. A rare summer resident.

XIII.—Family GRUIDÆ. Cranes.

65. Grus americana Linn. Whooping Crane. Migratory; rare.
66. Grus canadensis Linn. Little Brown Crane. Migratory; common.
67. Grus mexicana Müll. Sandhill Crane. Migratory; common.

XIV.—Family RALLIDÆ. Rails, Gallinules, and Coots.

68. Rallus elegans Aud. King Rail. Summer resident; common.
69. Rallus virginianus Linn. Virginia Rail. A rare summer resident; a common migrant.
70. Porzana carolina Linn. Sora. Summer resident; rare.
71. Porzana noveboracensis Gmel. Yellow Rail. Summer resident; rare.
72. Porzana jamaicensis Gmel. Black Rail. Summer resident; rare.
73. Ionornis martinica Linn. Purple Gallinule. Accidental. Added to the list in 1893 by D. E. Lantz.
74. Gallinula galeata Licht. Florida Gallinule. A very rare summer resident
75. Fulica americana Gmel. American Coot. Summer resident; abundant.

XV.—Family PHALAROPODIDÆ. Phalaropes.

76. Phalaropus lobatus Linn. Northern Phalarope. Migratory; rare.
77. Phalaropus tricolor Vieill. Wilson's Phalarope. Migratory; rare.

XVI.—Family RECURVIROSTRIDÆ. Avocets and Stilts.

78. Recurvirostra americana Gmel. American Avocet. A rare summer resident; a common migrant.

XVII.—Family SCOLOPACIDÆ. Snipes, Sandpipers, and Curlews.

79. Philohela minor Gmel. American Woodcock. Summer resident; rare.
80. Gallinago delicata Ord. Wilson's Snipe. Migratory; common.
81. Macrorhamphus scolopaceus Say. Long-billed Dowitcher. Migratory; common.
82. Micropalama himantopus Bonap. Stilt Sandpiper. Migratory; rare.
83. Tringa canutus Linn. Knot. Migratory; rare.
84. Tringa maculata Vieill. Pectoral Sandpiper. Migratory; common.
85. Tringa fuscicollis Vieill. White-rumped Sandpiper. Migratory; common.
86. Tringa bairdii Coues. Baird's Sandpiper. Migratory; common.
87. Tringa minutilla Vieill. Least Sandpiper. Migratory; abundant.
88. Tringa alpina pacifica Coues. Red-backed Sandpiper. Migratory; rare.
89. Ereunetes pusillus Linn. Semipalmated Sandpiper. Migratory; rare.
90. Calidris arenaria Linn. Sanderling. Accidental.
91. Limosa fedoa Linn. Marble Godwit. Migratory; occasional.
92. Limosa hæmastica Linn. Hudsonian Godwit. Migratory; rare.
93. Totanus melanoleucus Gmel. Greater Yellow-legs. Migratory; common.
94. Totanus flavipes Gmel. Yellow-legs. Migratory; abundant.
95. Helodromus solitarius Wils. Solitary Sandpiper. Migratory; common.
96. Symphemia semipalmata inornata Brewst. Western Willet. Migratory; rare.

97. Bartramia longicauda Bechst. Bartramian Sandpiper. A common summer resident.
98. Tryngites subruficollis Vieill. Buff-breasted Sandpiper. Migratory; rare.
99. Actitis macularia Linn. Spotted Sandpiper. A rare summer resident; an abundant migrant.
100. Numenius longirostris Wils. Long-billed Curlew. A rare summer resident; a common migrant.
101. Numenius borealis Forst. Eskimo Curlew. Migratory; abundant.

XVIII.—Family CHARADRIIDÆ. Plovers.

102. Charadrius dominicus Müll. American Golden Plover. Migratory; common.
103. Ægialitis vocifera Linn. Kill-deer. An abundant summer resident.
104. Ægialitis semipalmata Bonap. Semipalmated Plover. Migratory; not common.
105. Ægialitis nivosa Cass. Snowy Plover. A rare summer resident in southwestern Kansas.
106. Ægialitis montana Towns. Mountain Plover. A common summer resident.
107. Arenaria interpres Linn. Turnstone. Accidental. A single specimen, taken by Mr. F. E. Forbes, of Topeka, on the Kansas river, August 16, 1898, was sent to me for determination. New to the Kansas bird fauna.

XIX.—TETRAONIDÆ. Grouse, Partridges, Quail.

108. Colinus virginianus Linn. Bob-white. An abundant resident.
109. Colinus virginianus texanus Lawr. Texas Bob-white. A very rare resident in southwestern Kansas; formerly not uncommon.
110. Bonasa umbellus Linn. Ruffed Grouse. A very rare resident in eastern Kansas.
111. Tympanuchus americanus Reich. Prairie Hen. Formerly an abundant resident; still common in some parts of central Kansas.
112. Tympanuchus pallidicinctus Ridgw. Lesser Prairie Hen. A rare resident in southwestern Kansas.
113. Pediœcetes phasianellus campestris Ridgw. Prairie Sharp-tailed Grouse. A common resident in western Kansas.

XX.—Family PHASIANIDÆ. Pheasants.

114. Meleagris gallopavo Linn. Wild Turkey. Once an abundant resident now extremely rare, if not already extinct, in southwestern Kansas.

XXI.—Family COLUMBIDÆ. Pigeons.

115. Ectopistes migratorius Linn. Passenger Pigeon. A very rare summer resident; once abundant.
116. Zenaidura macroura Linn. Mourning Dove. An abundant summer resident.

XXII.—Family CATHARTIDÆ. American Vultures.

117. Cathartes aura Linn. Turkey Vulture. An abundant summer resident.
118. Catharista urubu Vieill. Black Vulture. A very rare summer resident.

XXIII.—Family FALCONIDÆ. Falcons, Hawks, Eagles, Kites.

119. Elanoides forficatus Linn. Swallow-tailed Kite. An irregular summer resident.
120. Ictinia mississippiensis Wils. Mississippi Kite. A rare summer resident.
121. Circus hudsonius Linn. Marsh Hawk. Resident; common.
122. Accipiter velox Wils. Sharp-shinned Hawk. A rare winter sojourner; common in migration.
123. Accipiter cooperi Bonap. Cooper's Hawk. Resident; common.
124. Accipiter atricapillus Wils. American Goshawk. A rare winter visitant.
125. Buteo borealis Gmel. Red-tailed Hawk. Resident; common.
126. Buteo borealis kriderii Hoopes. Krider's Hawk. A rare visitant.
127. Buteo borealis calurus Cass. Western Red-tail. A not uncommon winter sojourner.
128. Buteo borealis harlani Aud. Harlan's Hawk. A rare winter visitant.
129. Buteo lineatus Gmel. Red-shouldered Hawk. Resident; common.
130. Buteo swainsoni Bonap. Swainson's Hawk. Resident; rare in eastern Kansas, common elsewhere.
131. Buteo latissimus Wils. Broad-winged Hawk. A rare summer visitant.
132. Archibuteo lagopus sanctijohannis Gmel. American Rough-legged Hawk. A common winter sojourner.
133. Archibuteo ferrugineus Licht. Ferruginous Rough-leg. Resident; rare in eastern Kansas, common elsewhere.
134. Aquila chrysaëtus Linn. Golden Eagle. A rare resident; rather common in winter.
135. Haliaetus leucocephalus Linn. Bald Eagle. A rare resident; rather common in winter.
136. Falco rusticolus Linn. Gray Gyrfalcon. Accidental. Added to the list in 1881 by Dr. C. P. Blachly.
137. Falco mexicanus Schl. Prairie Falcon. A rare resident.
138. Falco peregrinus anatum Bonap. Duck Hawk. Resident; not uncommon.
139. Falco columbarius Linn. Pigeon Hawk. Migratory; rare.
140. Falco richardsonii Ridgw. Richardson's Merlin. Migratory; rare in eastern Kansas, common in western Kansas.
141. Falco sparverius Linn. American Sparrow Hawk. Resident; abundant.
142. Pandion haliaetus carolinensis Gmel. American Osprey. A rare summer resident.

XXIV.—Family STRIGIDÆ. Barn Owls.

143. Strix pratincola Bonap. American Barn Owl. Resident; common.

XXV.—Family BUBONIDÆ. Horned Owls, etc.

144. Asio wilsonianus Less. American Long-eared Owl. Resident; common.
145. Asio accipitrinus Pall. Short-eared Owl. Resident; common.
146. Syrnium nebulosum Forst. Barred Owl. Resident; common.
147. Nyctale acadica Gmel. Saw-whet Owl. Winter sojourner; not common.
148. Megascops asio Linn. Screech Owl. Resident; abundant.
149. Bubo virginianus Gmel. Great Horned Owl. Resident; common.
150. Bubo virginianus subarcticus Hoy. Western Horned Owl. Accidental.
151. Nyctea nyctea Linn. Snowy Owl. Winter sojourner; rare.
152. Speotyto cunicularia hypogæa Bonap. Burrowing Owl. Resident; abundant in central and western Kansas.

XXVI.—Family PSITTACIDÆ. Paroquets.

153. Conurus carolinensis Linn. Carolina Paroquet. Formerly a common resident, but now extinct.

XXVII.—Family CUCULIDÆ. Cuckoos.

154. Coccyzus americanus Linn. Yellow-billed Cuckoo. Summer resident; common.
155. Coccyzus erythrophthalmus Wils. Black-billed Cuckoo. A rare summer resident.

XXVIII.—Family ALCEDINIDÆ. Kingfishers.

156. Ceryle alcyon Linn. Belted Kingfisher. Summer resident; common.

XXIX.—Family PICIDÆ. Woodpeckers.

157. Dryobates villosus Linn. Hairy Woodpecker. Resident; common.
158. Dryobates pubescens Linn. Downy Woodpecker. Resident; common.
159. Sphyrapicus varius Linn. Yellow-bellied Sapsucker. Migratory; rare.
160. Sphyrapicus varius nuchalis Baird. Red-naped Sapsucker. Migratory; rare.
161. Ceophlœus pileatus abieticola Bangs. Pileated Woodpecker. A very rare resident.
162. Melanerpes erythrocephalus Linn. Red-headed Woodpecker. A common summer resident.
163. Melanerpes torquatus Wils. Lewis's Woodpecker. A very rare visitant in western Kansas.
164. Melanerpes carolinus Linn. Red-bellied Woodpecker. Resident; common.
165. Colaptes auratus luteus Bangs. Flicker. Resident; common.
166. Colaptes cafer Gmel. Red-shafted Flicker. Resident; rare in eastern Kansas, not uncommon in western Kansas.

XXX.—Family CAPRIMULGIDÆ. Goatsuckers, Night-hawks.

167. Antrostomus carolinensis Linn. Chuck-will's-widow. Accidental; a specimen of this bird was captured on the Arkansas river, south of Wichita, June 12, 1898, by Dr. R. Matthews, of Wichita, who submitted it to me for determination.
168. Antrostomus vociferus Wils. Whippoorwill. Summer resident; rare.
169. Phalænoptilus nuttalli Aud. Poor-will. A common summer resident.
170. Phalænoptilus nuttalli nitidus Brewst. Frosted Poor-will. A common summer resident.
171. Chordeiles virginianus Gmel. Night-hawk. A common summer resident in eastern Kansas.
172. Chordeiles virginianus henryi Cass. Western Night-hawk. A common summer resident in western Kansas.

XXXI.—Family CYPSELIDÆ. Swifts.

173. Chætura pelagica Linn. Chimney Swift. An abundant summer resident.

XXXII.—Family TROCHILIDÆ. Humming-birds.

174. Trochilus colubris Linn. Ruby-throated Humming-bird. A common summer resident.

XXXIII.—TYRANNIDÆ. Tyrant Flycatchers.

175. Milvulus forficatus Gmel. Scissor-tailed Flycatcher. Summer resident; not uncommon in southern Kansas. A specimen taken at Colby in August, 1897, was sent me by W. V. Smith.
176. Tyrannus tyrannus Linn. Kingbird. Summer resident; abundant.
177. Tyrannus verticalis Say. Arkansas Kingbird. A common summer resident in western Kansas.
178. Myiarchus crinitus Linn. Crested Flycatcher. An abundant summer resident in eastern Kansas.
179. Sayornis phœbe Lath. Phœbe. A common summer resident in eastern Kansas.
180. Sayornis saya Bonap. Say's Phœbe. A common summer resident in western Kansas.
181. Contopus borealis Swains. Olive-sided Flycatcher. A rare summer resident.
182. Contopus virens Linn. Wood Pewee Summer resident; common.
183. Contopus richardsonii Swains. Western Wood Pewee. A rare summer resident in western Kansas.
184. Empidonax acadicus Gmel. Acadian Flycatcher. Not an uncommon summer resident in eastern Kansas.
185. Empidonax pusillus traillii Aud. Traill's Flycatcher. A rare summer resident; common in migration.
186. Empidonax minimus Baird. Least Flycatcher. Migratory; common.

XXXIV.—Family ALAUDIDÆ. Larks.

187. Otocoris alpestris leucolæma Coues. Pallid Horned Lark. A winter sojourner; sometimes common. Added to the list in 1890 by J. Dwight, jr.
188. Otocoris alpestris praticola Hensh. Prairie Horned Lark. A common resident in eastern Kansas.
189. Otocoris alpestris arenicola Hensh. Desert Horned Lark. A common resident in central and western Kansas.

XXXV.—Family CORVIDÆ. Magpies, Crow, Jays, etc.

190. Pica pica hudsonica Sab. American Magpie. Winter visitant; rare.
191. Cyanocitta cristata Linn. Blue Jay. Resident; abundant.
192. Corvus corax sinuatus Wagl. American Raven. Formerly resident; now a rare visitant.
193. Corvus cryptoleucus Couch. White-necked Raven. A rare resident in western Kansas.
194. Corvus americanus Aud. American Crow. An abundant resident.
195. Picicorvus columbianus Wils. Clark's Nutcracker. Accidental.
196. Cyanocephalus cyanocephalus Wied. Piñon Jay. Accidental.

XXXVI.—Family ICTERIDÆ. Blackbirds, Orioles, etc.

197. Dolichonyx oryzivorus Linn. Bobolink. A rare summer resident; common in migration.
198. Molothrus ater Bodd. Cowbird. An abundant summer resident.
199. Xanthocephalus xanthocephalus Bonap. Yellow-headed Blackbird. A not common summer resident; abundant in migration.
200. Agelaius phœniceus Linn. Red-winged Blackbird. Summer resident; occasional in winter.
201. Sturnella magna Linn. Meadow-lark. An abundant resident in eastern Kansas.

202. Sturnella magna neglecta Aud. Western Meadow-lark. An abundant resident in central and western Kansas.
203. Icterus spurius Linn. Orchard Oriole. An abundant summer resident.
204. Icterus galbula Linn. Baltimore Oriole. A summer resident.
205. Icterus bullocki Swains. Bullock's Oriole. A very rare summer resident.
206. Scolecophagus carolinus Müll. Rusty Blackbird. Winter sojourner; not common.
207. Scolecophagus cyanocephalus Wagl. Brewer's Blackbird. An occasional resident in western Kansas; common in migration.
208. Quiscalus quiscula æneus Ridgw. Bronze Grackle. An occasional resident; abundant in summer.

XXXVII.—Family FRINGILLIDÆ. Finches, Sparrows, etc.

209. Coccothraustes vespertinus montanus Ridgw. Western Evening Grosbeak. Migratory; rare.
210. Carpodacus pupureus Gmel. Purple Finch. Winter sojourner; rare.
211. Carpodacus mexicanus frontalis Say. House Finch. Accidental. Added to the list in 1894 by V. L. Kellogg and H. W. Menke.
212. Loxia curvirostra bendirei Ridgw. Bendire's Crossbill. A very rare winter visitant. (Entered in previous catalogues as the Mexican Crossbill. See Ridgway's The Birds of North and Middle America, part I, pages 50–53.) Added to the list in 1886 by L. L. Dyche.
213. Acanthis linaria Linn. Red-poll. Winter visitant; rare.
214. Astragalinus tristis Linn. American Goldfinch. Resident; abundant.
215. Spinus pinus Wils. Pine Siskin. Winter resident; sometimes common.
216. Passerina nivalis Linn. Snowflake. Winter visitant; rare.
217. Calcarius lapponicus Linn. Lapland Longspur. Winter sojourner; abundant.
218. Calcarius pictus Swains. Smith's Longspur. Winter sojourner; common.
219. Calcarius ornatus Towns. Chestnut-colored Longspur. Resident; common.
220. Rhyncophanes maccownii Lawr. McCown's Longspur. A common winter sojourner in western Kansas.
221. Pocecetes gramineus Gmel. Vesper Sparrow. A rare summer resident; common in migration.
222. Ammodramus sandwichensis savanna Wils. Savanna Sparrow. Migratory; abundant.
223. Ammodramus sandwichensis alaudinus Bonap. Western Savanna Sparrow. Migratory; not uncommon.
224. Ammodramus savannarum passerinus Wils. Grasshopper Sparrow. Summer resident; abundant.
225. Ammodramus henslowii Aud. Henslow's Sparrow. Summer resident; rare.
226. Ammodramus leconteii Aud. Leconte's Sparrow. Migratory; common.
227. Ammodramus caudacutus nelsoni Allen. Nelson's Sparrow. Summer resident; rare.
228. Chondestes grammacus Say. Lark Sparrow. Summer resident; abundant.
229. Zonotrichia querula Nutt. Harris's Sparrow. Winter sojourner; abundant.
230. Zonotrichia leucophrys Forst. White-crowned Sparrow. Migratory; common.
231. Zonotrichia leucophrys intermedia Ridgw. Intermediate Sparrow. Migratory; common.
232. Zonotrichia albicollis Gmel. White-throated Sparrow. Migratory; common.
233. Spizella monticola Gmel. Tree Sparrow. Winter resident; abundant.

234. Spizella monticola ochracea Brewst. Western Tree Sparrow. Not an uncommon winter sojourner in western Kansas.
235. Spizella socialis Wils. Chipping Sparrow. Summer resident; common in eastern Kansas.
236. Spizella pallida Swains. Clay-colored Sparrow. Migratory; common.
237. Spizella pusilla Wils. Field Sparrow. Summer resident; common in eastern Kansas.
238. Junco aikeni Ridgw. White-winged Junco. A rare winter visitant in western Kansas.
239. Junco hyemalis Linn. Slate-colored Junco. Winter sojourner; abundant.
240. Junco hyemalis oregonus Towns. Oregon Junco. A common winter sojourner.
241. Peucæa cassini Woodh. Cassin's Sparrow. A common summer resident in western Kansas.
242. Melospiza fasciata Gmel. Song Sparrow. A not uncommon winter sojourner; common in migration.
243. Melospiza lincolni Aud. Lincoln's Sparrow. Migratory; common.
244. Melospiza georgiana Lath. Swamp Sparrow. A rare winter sojourner in eastern Kansas; common in migration.
245. Passerella iliaca Merr. Fox Sparrow. Winter sojourner; abundant in eastern, rare in western Kansas.
246. Passerella iliaca schistacea Baird. Slate-colored Sparrow. A rare winter visitant.
247. Pipilo erythrophthalmus Linn. Towhee. Resident; common in eastern Kansas.
248. Pipilo maculatus arcticus Swains. Arctic Towhee. Winter sojourner; rare in eastern, common in central and western Kansas.
249. Cardinalis cardinalis Linn. Cardinal. Resident; common.
250. Habia ludoviciana Linn. Rose-breasted Grosbeak. Summer resident; common.
251. Habia melanocephala Swains. Black-headed Grosbeak. Summer resident; common in western half of the state.
252. Guiraca cærulea Linn. Blue Grosbeak. A common summer resident in central and western Kansas.
253. Cyanospiza cyanea Linn. Indigo Bunting. A common summer resident in eastern Kansas.
254. Cyanospiza amœna Say. Lazuli Bunting. A rare summer resident in western Kansas.
255. Cyanospiza ciris Linn. Painted Bunting. A common summer resident in southwestern Kansas.
256. Spiza americana Gmel. Dickcissel. Summer resident; abundant in eastern and central Kansas.
257. Calamospiza melanocorys Stein. Lark Bunting. A common summer resident in western Kansas.
258. Passer domesticus Linn. English Sparrow. Resident; abundant.
259. Piranga ludoviciana Wils. Louisiana Tanager. Accidental in western Kansas.
260. Piranga erythromelas Vieill. Scarlet Tanager. A common summer resident.
261. Piranga rubra Linn. Summer Tanager. Summer resident; common in eastern Kansas.

XXXVIII.—Family HIRUNDINIDÆ. Swallows.

262. Progne subis Linn. Purple Martin. Summer resident; common.
263. Petrochelidon lunifrons Say. Cliff Swallow. Summer resident; common.
264. Hirundo erythrogaster Bodd. Barn Swallow. Summer resident; common.
265. Tachycineta bicolor Vieill. Tree Swallow. A rare summer resident; common in migration.
266. Clivicola riparia Linn. Bank Swallow. Summer resident; common.
267. Stelgidopteryx serripennis Aud. Rough-winged Swallow. A common summer resident.

XXXIX.—Family AMPELIDÆ. Waxwings.

268. Ampelis garrulus Linn. Bohemian Waxwing. Winter visitant; rare.
269. Ampelis cedrorum Vieill. Cedar Waxwing. Resident; varying from rare to abundant in different years.

XL.—Family LANIIDÆ. Shrikes.

270. Lanius borealis Vieill. Northern Shrike. A common winter sojourner.
271. Lanius ludovicianus Linn. Loggerhead Shrike. A rare winter visitant.
272. Lanius ludovicianus excubitorides Swains. White-rumped Shrike. Summer resident; common.

XLI.—Family VIREONIDÆ. Vireos.

273. Vireo olivaceus Linn. Red-eyed Vireo. Summer resident; common.
274. Vireo gilvus Vieill. Warbling Vireo. Summer resident; common.
275. Vireo flavifrons Vieill. Yellow-throated Vireo. Summer resident; less common.
276. Vireo solitarius Wils. Blue-headed Vireo. Migratory; rare.
277. Vireo atricapillus Woodh. Black-capped Vireo. A common summer resident in southwest Kansas.
278. Vireo noveboracensis Gmel. White-eyed Vireo. A common summer resident.
279. Vireo bellii Aud. Bell's Vireo. Summer resident; common.

XLII.—Family MNIOTILTIDÆ. Wood-warblers.

280. Mniotilta varia Linn. Black and White Warbler. Summer resident; not uncommon.
281. Protonotaria citrea Bodd. Prothonotary Warbler. A common summer resident in eastern Kansas.
282. Helmitherus vermivorus Gmel. Worm-eating Warbler. Migratory; rare.
283. Helminthophila pinus Linn. Blue-winged Warbler. A rare summer resident in eastern Kansas; common in migration.
284. Helminthophila ruficapilla Wils. Nashville Warbler. Migratory; rare.
285. Helminthophila celata Say. Orange-crowned Warbler. Migratory; common.
286. Helminthophila peregrina Wils. Tennessee Warbler. Migratory; rare.
287. Compsothlypis americana Linn. Parula Warbler. A rare summer resident; common in migration.
288. Dendroica æstiva Gmel. Yellow Warbler. Summer resident; abundant.
289. Dendroica cærulescens Gmel. Black-throated Blue Warbler. Migratory; rare.
290. Dendroica coronata Linn. Myrtle Warbler. A rare winter sojourner; common in migration.

291. Dendroica auduboni Towns. Audubon's Warbler. Migratory in western Kansas; common.
292. Dendroica maculosa Gmel. Magnolia Warbler. Migratory; rare.
293. Dendroica cærulea Wils. Cerulean Warbler. A rare summer resident; common in migration.
294. Dendroica pennsylvanica Linn. Chestnut-sided Warbler. Migratory; rare.
295. Dendroica striata Forst. Black-poll Warbler. Migratory; common.
296. Dendroica blackburniæ Gmel. Blackburnian Warbler. Migratory; rare.
297. Dendroica vigorsii Aud. Pine Warbler. A rare migrant in eastern Kansas.
298. Dendroica palmarum Gmel. Palm Warbler. A rare migrant in eastern Kansas.
299. Dendroica discolor Vieill. Prairie Warbler. A rare summer resident in eastern Kansas.
300. Seiurus aurocapillis Linn. Oven-bird. A common summer resident in eastern Kansas.
301. Seiurus noveboracensis notabilis Grinn. Grinnell's Water-thrush. Migratory; rare.
302. Seiurus motacilla Vieill. Louisiana Water-thrush. Summer resident.
303. Geothlypis formosa Wils. Kentucky Warbler. Summer resident in eastern Kansas; common.
304. Geothlypis philadelphia Wils. Mourning Warbler. Migratory; rare.
305. Geothlypis trichas occidentalis Brewst. Western Yellow-throat. Summer resident; common.
306. Icteria virens Linn. Yellow-breasted Chat. A common summer resident in eastern Kansas.
307. Icteria virens longicauda Lawr. Long-tailed Chat. A not uncommon summer resident in western Kansas.
308. Wilsonia mitrata Gmel. Hooded Warbler. A rare summer resident in eastern Kansas.
309. Wilsonia pusilla Wils. Wilson's Warbler. Migratory; common.
310. Wilsonia canadensis Linn. Canadian Warbler. Migratory in eastern Kansas; rare.
311. Setophaga ruticilla Linn. American Redstart. Summer resident in eastern Kansas; common.

XLIII.—Family Motacillidæ. Wagtails.

312. Anthus pennsylvanicus Lath. American Pipit. Migratory; common.
313. Anthus spragueii Aud. Sprague's Pipit. Migratory; rare in eastern, common in western Kansas.

XLIV.—Family Troglodytidæ. Mocking-birds, Thrashers, Wrens.

314. Mimus polyglottis Linn. Mocking-bird. Summer resident; common.
315. Galeoscoptes carolinensis Linn. Catbird. Summer resident; common.
316. Harporhynchus rufus Linn. Brown Thrasher. An abundant summer resident.
317. Salpinctus obsoletus Say. Rock Wren. Summer resident in central and western Kansas; common.
318. Thryothorus ludovicianus Lath. Carolina Wren. Resident; common.
319. Thryomanes bewickii leucogaster Salv. & God. Baird's Wren. A not uncommon resident in southwest Kansas.
320. Troglodytes aëdon aztecus Baird. Western House Wren, or Parkman's Wren. Summer resident; common.

321. Anorthura hyemalis Vieill. Winter Wren. Winter sojourner; rare.
322. Cistothorus stellaris Licht. Short-billed Marsh Wren. Migratory; rare.
323. Cistothorus palustris Wils. Long-billed Marsh Wren. A rare summer resident.

XLV.—Family CERTHIIDÆ. Creepers.

324. Certhia familiaris fusca Barton. Brown Creeper. A common winter sojourner.

XLVI.—Family PARIDÆ. Nuthatches, Titmice, Chickadees.

325. Sitta carolinensis Lath. White-breasted Nuthatch. Resident; common.
326. Sitta canadensis Linn. Red-breasted Nuthatch. Migratory; rare.
327. Parus bicolor Linn. Tufted Titmouse. Resident; abundant.
328. Parus atricapillus Linn. Chickadee. Resident; common.
329. Parus atricapillus septentrionalis Harris. Long-tailed Chickadee. A common resident.

XLVII.—Family SYLVIIDÆ. Kinglets and Gnatcatchers.

330. Regulus satrapa Licht. Golden-crowned Kinglet. A rare winter sojourner; common in migration.
331. Regulus calendula Linn. Ruby-crowned Kinglet. An occasional winter sojourner; common in migration.
332. Polioptila cærulea Linn. Blue-gray Gnatcatcher. A rare summer resident; common in migration.

XLVIII.—Family TURDIDÆ. Thrushes, Robins, Bluebirds.

333. Myiadestes townsendii Aud. Townsend's Solitaire. An occasional fall and winter visitant.
334. Hylocichla mustelina Gmel. Wood Thrush. A common summer resident.
335. Hylocichla aliciæ Baird. Gray-cheeked Thrush. Migratory; rare.
336. Hylocichla ustulata swainsonii Cab. Olive-backed Thrush. Migratory; common.
337. Hylocichla unalaskæ pallasii Cab. Hermit Thrush. Migratory; rare.
338. Merula migratoria Linn. American Robin. Resident; abundant.
339. Merula migratoria propinqua Ridgw. Western Robin. A rare visitant in western Kansas.
340. Hesperocichla nævia Gmel. Varied Thrush. Accidental. Added to the list in 1894 by V. L. Kellogg and H. W. Menke.
341. Sialia sialis Linn. Bluebird. A common resident in eastern and central Kansas; rare in western Kansas.
342. Sialia arctica Swains. Mountain Bluebird. A common winter sojourner in western Kansas; rare in eastern Kansas.

A NEW SPECIES OF FISH.

By F. F. Crevecœur, Onaga, Kan.

Read (by title) before the Academy, at Topeka, January 2, 1903.

WHEN the writer first came to Kansas, over thirty years ago, it was one of the principal pastimes of his boyish days to play in the streams in the spring of the year, when they ran nice and clear, and catch and release the small fishes that gathered on the riffles, presumably to spawn. Among these was a pretty little fellow colored with red and blue, and of quite small size compared with the other species frequenting the riffles with him. After a few years, when the country got more thickly settled and more land was brought under cultivation, and the streams after every rain of any consequence ran thick with the soil washed from the fields, and the deeper holes became filled with the heavier dirt, the fish was seen no more. Last spring, while collecting small fishes on the riffles on French creek—which flows from Nemaha county into the Vermillion near Onaga—with which to stock a recently finished pond on the writer's place, there was noticed a little fish darting among the stones that had a somewhat familiar look. A specimen was soon caught, and proved to be the fish, or one resembling it, which had so attracted our notice years ago. (It is well to notice here that, on account of the absence of any heavy rains early last spring, the creek in question was running perfectly clear, so anything swimming about in the shallower parts was easily seen.) As it was quite early yet, it being early in April, the fish did not have the bright colors, which it assumes later in the season, up to about the middle of May. Later on, when they had assumed their bright colors, a number were caught, and an effort was made to identify the species, with the help of David Starr Jordan and Barton Warren Evermann's admirable monograph on the fishes of North America, forming Bulletin No. 47 of the United States National Museum, but it was found that it did not agree with any species described there, and the conclusion was reached that ours was a new species, and so it was decided to describe it.

Etheostoma arcus-celestis, n. sp.

Total length less than two inches; usually one and three-fourths to one and seven-eighths inches. Body one and five-eighths inches. Head three and three-fifths in body; depth four and one-third in body; eye four and one-half in head. Dorsal fins IX to X, mostly IX-11; anal, II-7. In the first dorsal, the third, fourth and fifth spines are the longest; in the second dorsal, the middle rays

longer than the rest; in the anal, the first spine and the fifth and sixth rays are the longest. The height of first dorsal is contained eight and one-half times in body, while the length is contained three and one-half times; length of anal is contained three-fifths in second dorsal; origin of anal a little back of origin of second dorsal; pectorals seven-eighths in head. Scales in lateral line 18 plus pores 32=50; 7 rows of scales above lateral line and 10 below =17. Head and breast naked. Body subcompressed; mouth terminal; lower jaw included.

Coloring: Back grayish, tessellated more or less; there is a dark band front of first dorsal, and another between both dorsals extending about one-fourth down the sides; faint blue patch below eye; lower edge of gills orange; sides of body marked with nine blue bands extending obliquely downwards and backwards, separated by bands of orange; in one specimen examined there were eleven such blue bands, while one or two had only eight; belly of a lighter blue than bands of side. First dorsal fin edged with band of dark blue, followed by a narrow band of whitish, while the basal two-thirds of fin is of bright orange, with a row of light-colored interradial spots; outer three-fourths of second dorsal lighter orange than that of first dorsal; next follows a band of light blue, while the base of fin is of a darker orange than that of the outer edge; ventrals blue, with the rays blackish; anal dark blue; pectorals and caudal translucent without any coloring.

Dorsals usually separated; caudal rounded, truncate.

Female smaller than male; about one and one-half inches in total length. Color darker than male, without the blue bands of its consort, or having them but faintly marked.

This species is distinguished from *E. cæruleum* Storer, to which it seems to be most nearly related, by its smaller size, less number of bands on sides, absence of color in caudal fin, anal fin dark blue instead of orange, with deep blue in front and behind, and without the blue at base and edge of second dorsal.

NOTES ON THE FOOD HABITS OF CALIFORNIA SEA-LIONS.

(*Zalophus californianus* Lesson.)

By L. L. Dyche, University of Kansas, Lawrence.

Read before the Academy, at Topeka, December 31, 1902.

THE following observations on the food habits of sea-lions were made during the months of June, July, August, and September, 1899. The region visited was that of Monterey bay, California, and the coast south of the bay for a distance of about twenty-five miles. Point Pinos marks the southern point of entrance between Monterey bay and the Pacific ocean. Within a radius of two or three miles of this point most of the salmon fishing is done by the Monterey fishermen.

No. 1. June 25. Found old sea-lion cow dead on beach near Point Pinos. Examined the stomach and found that it was full of the flesh of small squids. Beaks, arms and the so-called pens of the squids were common in the half-digested and half-decayed mass.

No. 2. June 27. Found a dead sea-lion cow (bullet hole in her head) about one-half mile south of Point Pinos. Stomach full of squids, many of them in good state of preservation.

No. 3. June 27. This animal was found within a few rods of No. 2. It was a two- or three-year-old bull. It had been dead for some time, as the hair was slipping. Stomach was full of the chewed-up arms of an octopus or devil-fish.

No. 4. June 30. About two miles south of Point Pinos found carcass of old bull sea-lion which had been washed upon the shore in a mass of seaweeds. That part of the muzzle containing the whiskers had been cut away. The penis bone had also been cut out. I was told by fishermen that Chinamen valued these articles, and that they would pay about five dollars for the whisker bristles of an old bull and the same price for the penis bone. This animal had been dead some time. There was a bullet-hole in its skull. Dissection showed that its stomach was gorged with the flesh of a "giant squid," as the large squids (weighing from twenty to forty pounds) of that coast are called. There were pieces of flesh taken from the stomach as large as my hand.

No. 5. July 7. Found sea-lion cow at Point Pinos. Had been washed ashore during the night. The only material found in the stomach was a few parts of squid beaks and a bunch half as large as one's fist of the pens from the backs of squids.

No. 6. July 9. Found a sea-lion cow dead on the beach near "seal

rocks," about three miles south of Point Pinos. Stomach was well filled with the chewed-up parts of a giant squid.

Nos. 7 and 8. July 16. Found two sea-lion cows about a mile south of Point Pinos. Both had been feeding on giant squids. The stomach of one contained about two quarts, that of the other about a gallon, of the chewed-up flesh and arms of giant squids.

The above animals were all found within three miles of Point Pinos. They had been killed, as I was informed by the fishermen, because they were killing and feeding upon the fish, mostly salmon, that were, at this time of the year, coming into the bay. When the weather was favorable, it was not an uncommon thing to see from twenty-five to seventy-five salmon fishermen in small sailboats trolling for salmon.

These animals were killed at the place during the time of the year when the salmon was being taken by fishermen. Yet there was not a fish scale or bone detected in the stomach of any one of them.

On the 20th of July I established a camp about twelves miles south of Monterey bay, between Point Carmel and the lighthouse. About a mile from shore there were two rocky islands. From 100 to 300 sea-lions could be seen on these rocks almost any day. I learned afterwards that they were all cows and calves—not a bull was seen there during my stay of about a month.

Between July 20 and August 16 I killed twelve sea-lions. They were yearlings, two-year-olds, and old cows. The skins and skulls of these animals were saved for museum specimens. Their stomachs were examined and the contents carefully noted. Seven out of the twelve had their stomachs well filled with the flesh of the giant squids. One had gorged itself with an octopus. The other four had empty stomachs, except some remains of the pens and beaks of squids, the quantity varying from a half pint to perhaps a quart.

During this time three animals—all cows—were found dead on the shore. Dissection showed that all had been eating squids.

I found the carcass of an old bull which had been killed, so a ranchman informed me, early, at least not later than the middle of June. This went to show that the bulls were in that locality at that time. The whiskers and penis bone had been taken. I took the skull and examined the decaying stomach, which was full of giant squid meat.

I examined but one more animal, and that was an old cow. She was thrown up on the beach near the seal rocks, about three miles south of Point Pinos. This animal had just been killed, as the skin was in such good condition that it was saved for a specimen. The stomach was gorged with the flesh from an octopus.

The salmon fishermen who were present when the stomachs of the sea-lions were opened up were very much surprised when they saw

that the animals had been feeding upon squids. Some of them said it was because salmon had become scarce and that the sea-lions were compelled to eat squids. These same fishermen told me that from ten to twenty-five years ago there were a great many salmon, but that now the salmon were very scarce and hard to catch. They said that the sea-lions had either destroyed them or "run them out of the country."

When asked if there were not many more sea-lions ten to twenty-five years ago than at present, they admitted that there were. One old fisherman said that twenty-five years ago there were "sea-lions everywhere on all the rocks."

I was informed by the ranchmen and by fishermen that there were no fish within two or three miles of the sea-lion rocks near my camp; the lions had either caught or driven them away. However, I succeeded in catching a dozen rock-cod between shore and the seal rocks. Afterwards, my boatman, George Carr, an old salmon fisherman, caught plenty of rock-cod weighing from one to eight pounds each within sixty feet of the flat rock where from 100 to 300 sea-lions landed every day. He was very much surprised that he could catch so many fish in such a place. Around these rocks, where the sea-lions had lived for ages, proved to be the best fishing-grounds we could find in that locality. The fish could not have been annoyed very much by the sea-lions or they would not have remained there.

My boatman landed me a number of times on the rocky islands. In places the rocks were covered over and partially concealed by the droppings from the animals. In some depressions the manure was a foot deep. I looked for fish bones and scales, but not a single one was discovered. Parts of the pens from the backs of squids were very common in the excrement.

The salmon fishermen told me that they sometimes caught salmon that had pieces bit out of them by sea-lions. They showed me one such specimen. The cut was a smooth one, such as might have been made by a shark, but not a rugged tear, such as the large teeth of the sea-lion would make.

Whenever the sea-lions came into the bay during the salmon-fishing season the fishermen would say that they were after the salmon. They saw them diving in the waters where the salmon were, but there was no evidence that I could see or that they could produce that would show that the lions were after the salmon.

The squids were in the bay at this season of the year. It is more than likely that the lions were after the squids.

The animals that I found dead had all been shot, as a rule in the head. There is just one point that I am not sure of, and that is in

regard to the identification of the material in some of the animals that had been dead for some time. It was hard to tell in some instances whether the contents of the stomach was squid or octopus, or squid and octopus combined.

The above observations were all made in one locality and during the summer season. It would take a series of observations extending through the entire year and from different localities to give the most satisfactory results. The stomachs of but two male animals were examined. The idea occurred to me that if the animals lived in a locality where there were no squids or devil-fish they might live on a fish diet. However, the observations I made go to show, I think, that where fish and squids are both in the waters the sea-lions prefer the squids.

FOOD HABITS OF THE COMMON GARDEN MOLE.

(*Scalops aquaticus machrinus* Rafinesque.)

By L. L. Dyche, University of Kansas, Lawrence.

Read before the Academy, at Topeka, January 2, 1903.

COMMENCING with January, 1894, I have examined the stomachs of sixty-seven common garden moles of the above species. No specimens were taken during the months of December and February. The other months are represented by from two to a dozen specimens each. The moles were taken for the most part either on the University campus, which is rather high ground, or in the yard around my house, on rather low ground. No effort was made to take any particular number at any particular time or season. July, August and September have but two representatives each, while October and November are represented by about a dozen specimens each. Most of the animals were caught by using the mole traps which are sold in the markets—the kinds that work by the use of a coiled spring, which, when set off, drives a number of sharp spikes down into the ground and through the mole.

Out of the sixty-seven specimens taken, seventeen of the stomachs contained nothing, or only a trace of food. Fifty stomachs contained more or less food, many of them being well filled. To determine the nature and quantity of the food in the stomachs it was necessary to place the contents in a dish of water. After gentle washing the mass was placed on paper or a thin cloth seive, and the water allowed to filter away or be absorbed. The food matter was then examined with a hand or a low-power compound microscope. The different kinds of materials were pushed together and examined to determine the kind and relative quantity of food. One difficulty an observer has to contend with is the fact that the mole frequently chews its food very fine. Earthworms are easily made out, owing to the skins, which are tough. They hold together well and are easily recognized. While the skins of the grubs and the various kinds of larvæ are rather tough, and, as a rule, show the general shape of the animals, the head-parts, on the other hand, are comparatively hard, and the fine teeth of the mole crush them so much that they are hard to recognize. No attempt has been made to distinguish species, though the grubs of the June beetles (*Lachnosterna*) were frequently recognized. Coleopterous beetles could be made out quite satisfactorily, provided one had the time and patience to work the material over. Almost all of the beetles

devoured were of the black or blackish-brown ground varieties, such, for instance, as *Harpalus pennsylvanicus*.

By referring to a chart which I have prepared, this paper becomes much more intelligible. It gives the dates of capture of the specimens, the kind and per cent., in quantity, as nearly as it could be estimated, of the various foods found in each stomach.

Earthworms constitute the most common article of food. Thirty-eight out of the fifty specimens had eaten earthworms, and six had eaten nothing else.

Earthworms constitute 42.20 per cent. of the entire food. Twenty-seven of the animals had eaten ground-beetles, which make up 22.7 per cent. of the entire food supply. Thirty-four stomachs contained grubs and larvæ of various kinds, which constituted 22.8 per cent. of the stomach contents. Four stomachs contained from 5 to 20 per cent. each of insect eggs, apparently those of grasshoppers.

One stomach contained twenty and another thirty ants, making in each case about 20 per cent. of the food.

Three stomachs contained myriopods (*Geophilus*). One mole had eaten seven specimens and another eleven, making 100 per cent. of the food in both cases, as there was no trace of anything else.

Vegetable food was represented by 3.7 per cent. Four of the animals had eaten kernels of corn, which made up from 10 to 65 per cent. of the food. These animals were taken in January and October. The animals were caught near fields where kernels of corn had perhaps been trampled into the earth and had become softened. Otherwise I do not see how the fine teeth of the mole could have chewed up the kernels. Two of these specimens, one taken January 18, 1894, and one October 6, 1894, had the stomachs well filled with corn. There was little doubt about the identification of the material, as the professors in the department of botany at the University assisted in its determination.

Seeds of grass, hemp and some long seeds that resembled small rye grains represented 20 per cent. of the food of a specimen taken January 8, 1894.

Four stomachs harbored from three to seven white parasitic worms about three-quarters of an inch long.

One animal, taken November 9, 1894, had an enlarged and diseased stomach. There were a number of warty-like blisters on the inside of the stomach as large as wheat grains. When opened, they contained a black substance that resembled the earth mud frequently found in the stomachs of the animals that had been feeding upon earthworms.

FOOD HABITS OF THE COMMON GARDEN MOLE.

Date of capture.	Per cent. of different kinds of food found in stomachs.				Kinds of food rarely found.		
	Earthworms	Beetles	Grubs and larvæ	Vegetable food			
January 17, 1894	15	25	45		Insect eggs (grasshoppers)	15	
" 18, 1894	10	25		Corn, 65			
" 18, 1894		40	40	Seeds, 20			*a*
" 19, 1894	25	30	15	Corn, 30			
March 13, 1894	65		35				
" 18, 1894	90		10				
" 22, 1894	40	30	20		Insect eggs	10	*b*
" 31, 1894	65	25	5		"	5	
April 7, 1894		35	65				*c*
" 7, 1894	15	65	20				
" 24, 1894	50	15	25		Brown chrysalis	10	
" 25, 1894	65	10	25				
May 3, 1901					Myriopods (*Geophilus*)	100	*d*
" 6, 1901		40			" "	60	
" 11, 1901					" "	100	
" 17, 1901	30	40	30				
June 5, 1902	100						
" 7, 1902	80		20				
" 11, 1902	70		30				
" 14, 1902	50	20	30				
" 27, 1902	70		30				
July 7, 1901		100					
" 12, 1901	40	60					
August 4, 1901	80		20				
" 21, 1901	30	20	50				*e*
September 20, 1902	100						
" 27, 1902	100						
October 3, 1902	80		20				
" 4, 1894			90	Corn, 10			
" 5, 1894	100						
" 6, 1894		20	20	Corn, 60			
" 7, 1894	20	25	55				
" 8, 1894			100				*f*
" 10, 1894	90		10				
" 10, 1894	80		20				
" 21, 1902	60	10	30				
" 29, 1902	100						
" 29, 1902	100						
" 29, 1894	40	20	40				
" 30, 1902	90		10				
November 5, 1894	40		60				
" 5, 1894	30	50	20				
" 6, 1894	20	60	10		Insect eggs	10	
" 7, 1894		30	50		Ants (20 in number)	20	
" 9, 1894			70		Brown chrysalis chewed up,	30	*g*
" 12, 1894	15	85					
" 24, 1894	80				Ants (about 30 in number)	20	
" 24, 1894	25	75					
" 24, 1894		100					*h*
" 29, 1894		80	20				
Totals	2,160	1,135	1,140	185		380	

a. Hemp, grass, and other kinds of seeds.
b. Seven round, white parasitic worms about three-fourths of an inch long.
c. Three parasitic worms, each about three-fourths of an inch long, found in stomach.
d. Eleven specimens found in this mole's stomach; many whole specimens, but badly chewed.
e. Five white parasitic worms.
f. Nine *Lachnosterna* or June beetle grubs. Entire skins present, with hard head-parts pretty well chewed up.
g. Stomach enlarged; covered on inside with black, warty growths.
h. Three white parasitic worms about three-fourths of an inch long.

Total amounts of 50 specimens examined that contained food:
Average of earthworms, 43.20 per cent.
Average of beetles, 22.7 per cent.
Average of grubs and larvæ, 22.8 per cent.
Average of vegetable matter, 3.7 per cent.
Average of kinds of food rarely found, 7.6 per cent.
Seventeen stomachs contained nothing or only a small trace of food.

Another chart made from the examination of the stomachs of fifty other animals would undoubtedly be quite different from this one. However, this chart will give an idea based on the actual study of fifty stomachs, and will be a beginning for some one who may, in the future, give more time to the subject, and work it up more in detail.

I think that it is safe to say that, when the ground is moist and the earthworms are active, the animals feed freely upon them. When the ground is dry, and early in the spring or late in the fall, when the earthworms are not so active, grubs and beetles are eaten more freely and constitute a greater proportion of the food than they otherwise would.

It is evident that the damage done to lawns, gardens and fields by moles is due chiefly not to the food the animals eat, but rather to their manner of securing it. Moles make many burrows or runways two or three inches under the ground by digging and then lifting up the soil with their shoulders. In making these runways, the little animals root up and destroy many plants, and especially the grass that usually grows on the runways in lawns and pastures. Mice frequently follow along in the runways made by the moles, and do considerable damage to bulbs, roots, and grains.

ADDITIONS TO THE LIST OF KANSAS COLEOPTERA

FOR THE YEARS 1901 AND 1902.

By W. KNAUS, McPherson, Kan.

Read before the Academy, at Topeka, January 1, 1903.

THE following list includes 111 species or varieties of coleoptera new to the Kansas list. Fifty-two of these were collected the season of 1901 at or near Onaga, seven or eight species at Topeka, and one at Galena, by F. F. Crevecœur; three in Douglas county and sixteen in Hamilton and Morton counties, by F. H. Snow, of the State University, Lawrence; two in Pratt and Barber counties, by S. G. Mead and Claude J. Shirk, of McPherson; two at Kansas City, Kan., by G. P. Mackenzie; one at Coolidge and two at Topeka, by Eugene Smyth; one at Oakley, by D. E. Lantz, and one at Tonganoxie, by T. B. Ashton.

Determinations and verifications were made principally by H. C. Fall, of Pasadena, Cal., and P. J. Schmitt, of Beatty, Pa. To these two gentlemen thanks are due.

In the list of 1899 and 1900 a few errors occurred, as follows: *Trechus rubens* is *chalybeus*. *Oodes texanas* is *cupreus*. *Rhynchites glastinus* is *cyanellus*. *Corticaria serrata* is *americanum*. *Agrilus abjectus* is probably an undescribed species. *Epitrax lobata* is *fuscula*. *Bruchus pauperculus* is *siminulum*, and *Trachyphœus asperatus* is an undescribed species.

15 Cicindela celeripes Lec. Morgan City, Clay county, 1875. Popenoe. Numerous specimens at Manhattan and Fort Riley, taken in 1902. Three specimens taken at Onaga in 1901.

15*a* Cicindela cursitans Lec. Two specimens, University collection, from Douglas county. Incorrectly reported in first list, volume V, Transactions Kansas Academy of Science.

20 Cicindela nigrocærulea Lec. Two specimens taken September 2, at Coolidge, by Eugene Smyth.

25*f* Cicindela limbalis Klug. Two specimens taken by Roy Rouch near Topeka.

25*h* Cicindela amœna Lec. A form of *splendida* taken at Lawrence, Topeka, Manhattan, Salina, McPherson, and, in fact, wherever *splendida* is found.

Cicindela transversa Leng. A race of *splendida* occurring wherever that species is taken.

Cicindela denverensis Casey. Specimens taken in October at Oakley by D. E. Lantz, and early in May, at Meade, Kan., and in Hamilton county in June, by F. H. Snow.

Cicindela var. unijuncta Casey. Occurs over the state associated with refanda.

25*h* Cicindela var. ponderosa Thoms. Occurs at Kansas City, Kan., Topeka, Manhattan, Medora, and Dodge City.
Cicindela knausii Leng. Salt marshes of Kansas, June and July. Hamilton county, F. H. Snow.
134 Calosoma lugubre Lec. Common at electric lights over central Kansas. Hamilton county, F. H. Snow.
Bembidium confusus Haywd. Topeka and McPherson, August.
Bembidium grandiceps Haywd. Berryton, September 1, Princeton, September 5, Crevecœur.
713 Dicælus leavipennis Lec. Hamilton county, June. F. H. Snow.
732 Badister pulchellus Lec. Hamilton county, June. F. H. Snow.
900 Lebia pectita Horn. Onaga, July 3.
931 Plochionus tumidus Hald. Onaga, May 10.
960 Hellumorpha texana Lec. Englewood and Hamilton county, June.
965 Brachynus minutus Harr. One specimen, Englewood, June 25.
967 Brachynus medius Lec. One specimen, electric light, McPherson, October 10.
1048 Oodes 14-striatus Chd. One specimen, southeast Kansas.
1308 Hydroporus divericornis Sharp. Two specimens, electric light, McPherson.
1595 Tropisternus striolatus Lec. Topeka, September 2.
1610 Berosus immaculatus Zimm. One specimen. Rago, June 25.
1672 Cercyon malanocephalum Linn. Onaga.
1678 Cercyon pygmæum Ill. Onaga, July 5.
Connophron, n. sp. One specimen. McPherson, May.
Connophron nigripenne Casey. Onaga.
Connophron innocuum Casey. Salina and Onaga.
1827 Connophron fossiges Lec. Topeka. One specimen. Popenoe.
1870 Tmesiphorus carinatus Say. Topeka. One specimen. Popenoe.
1888 Decarthron stigmosum Brend. Topeka. One specimen. Popenoe.
1915 Bryaxis conjuncta Lec. Topeka. One specimen. Popenoe.
Bryaxis species dubious. Topeka. One specimen. Popenoe.
1899 Batrisus frontalis Lec. Tonganoxie. Four specimens. T. B. Ashton.
1850 Eumicrus motschulskii Lec. One specimen. Douglas county.
1865 Chennium monilicornis Brend. One specimen. McPherson, May.
1873 Pilopius zimmermanii Lec. Two specimens. McPherson, May.
9367 Cylindrarctus crinifer Casey. One specimen. State University collection, Douglas county.
Batrisus striatus Casey. Onaga.
Reichenbachia ursina Casey. Manhattan.
Reichenbachia subsimilis Casey. Onaga.
Aleocharinii. Three unnamed species. Onaga, May, July, and September.
2243 Actobius sobrinus Er. Onaga, May 21.
2472 Eusthetus brevipennis Casey. Onaga, December 10.
9660 Leptorus texana Casey. Onaga, May 21.
9661 Leptorus bicolor Casey. Onaga, May 22.
2585 Pinophilus latipes Grav. McPherson, electric light, July.
9752 Oxytelus pennsylvanicus Er. Onaga, at light, July 26.
2899 Siagonum americanum Melsh. Onaga, July 6.
3013 Sacium biguttatum Lec. Onaga, November 13.

3047 Hippodamia spuria Lec. McPherson, electric light.
Hippodamia complex Casey. One specimen. McPherson.
Scymnus, n. sp. Onaga, June 2.
3178 Rhanis unicolor Zeigl. Onaga.
3427 Dermestes cadaverinus Fab. Kansas City, July.
3468 Hister arcuatus Say. Hamilton county, F. H. Snow.
Brachypterus, n. sp. Onaga.
3806 Corticaria elongata Horn. Onaga.
3901 Limnichus punctatus Lec. Onaga, July 25.
Stenelmis, n. sp. Onaga, August.
4164 Cryptohypnus æstivus Horn. Onaga, July 2.
Chrysobothris, n. sp. One specimen. Belvidere, June 24.
4821 Pyrophyga minuta Lec. Two specimens. Belvidere, June 24.
Polemius repandus Cos. Onaga, June 12.
4905 Podabrus simplex Coup. Kansas City, May 26.
4996 Collops eximius Er. Hamilton county. F. H. Snow.
5040 Anthocomus ventralis Horn. Morton county, June. F. H. Snow.
Clerus atriventris. Morton county, June.
5196 Hydnosera scabra Lec. Morton county, June. F. H. Snow.
Ptinidæ, n. gen., n. sp. Onaga, July 3.
Hemiptychus, n. sp. Onaga, August 15.
Aphodius, n. sp. Englewood, June 15.
10208 Aphodius tenuistriatus Horn. Englewood, June 25; Hamilton county, June. F. H. Snow.
5589 Bradycinetus serratus Lec. One specimen. Englewood, June 24.
5954 Mallodon melanopus Linn. One specimen collection. Chautauqua county. Eugene Smyth.
Cyllene lutosus Lec. Onaga, Kan.; also in the University collection.
6310 Leptura cruentata Hald. Onaga.
6355 Leptura ruficollis Say. Onaga.
Saperda var. connexa Joutel. Topeka. One specimen. June.
6513*b* Tetraopes basalis Lec. Hamilton county. F. H. Snow.
Saxinis, n. sp. Englewood, June 25. One specimen.
6661 Pachybrachis dubiosus Lec. Onaga.
10378 Phyllobrotica limbata Fab. Onaga, June 26–29.
10458 Phyllotreta pusilla Horn. Morton county, June. F. H. Snow.
Chætocnema, n. sp. Onaga, June 2.
7141 Bruchus pectoralis Horn. Onaga, July 16.
7142 Bruchus uniformis Lec. Morton county.
7201 Epitragus acutus Lec. Pratt and Barber counties, August and September.
7687 Orchesia castanea Mels. Benedict and Onaga.
7776 Tomoxia hilaris Say. Onaga, July 7.
7859 Mordellistema texana Smith. Morton county.
7922 Notoxus calcaratus Horn. One specimen. Morton county. F. H. Snow.
Anthicus lutulentus Casey. Onaga, June.
Lappus cursor Casey. Onaga, July 3.
7901 Xylophilus ater Lec. Onaga, June and July.
8118 Pyrota bilineata Horn. Pratt county, August 27.
Auletes subfasciatus Casey. Onaga, May 10.
8440 Listronotus sordidus Gyll. Onaga.

8481 Hilipis squamosus Lec. Galena. One specimen. Fall says: "I am surprised at this thing being found in Kansas. It is a beautiful thing, and rare. My single specimen is from Kentucky." "Georgia, Florida, under pine bark." (Lec.)

Plectromodes armatus Casey. Onaga, June 18.

10866 Cleonus grandirostris Casey. Morton county. F. H. Snow.

8572 Endalus aeratus Lec. Hamilton and Morton counties (F. H. Snow), and Englewood, June 25.

8668 Anthonomus decipiens Lec. One specimen. Onaga, May 9.

8915 Oomorphidius erasus Lec. Onaga, June 2. A rare species.

8937 Limnobaris rectirostris Lec. Onaga, June 18.

11166 Centrinus denticornis Casey. Morton and Hamilton counties. F. H. Snow.

Centrinus, n. sp. Onaga, July 3.

8988 Sphenophorus robustus Horn. One specimen. Medora, May.

9153 Scolytus regulosus Ratz. Onaga, October 28; Topeka, McPherson, Manhattan.

9224 Brachytarsus griseus Lec. Englewood, June 26. One specimen.

PRELIMINARY LIST OF MEDICINAL AND ECONOMIC KANSAS PLANTS,

WITH THEIR REPUTED THERAPEUTIC PROPERTIES.

By B. B. Smyth, Topeka.

Read (by title) before the Academy, at Iola, December 31, 1901.

THIS list is the outgrowth of the studies made by the writer while serving as "professor of medical botany" in the department of pharmacy of the Kansas Medical College, from 1891 to 1896, when the department was abolished. The preparation of the list, however, was not abandoned at the time, but has been kept up till the present time.

Medical botany is a relic of the past. It served a good purpose during the infancy of the science of medicine, and is one of the foundation stones upon which that grand science is built. It was a favorite study of our grandmothers, and even our mothers laid much stress upon the knowledge gained by experimentation with herbs, roots, etc. It must always remain as the most important science among semicivilized and crude peoples, who have not the knowledge of the modern doctor. Even among our own people, whenever remote from the influence of the modern man of medicine, necessity requires that people must and should know something of the ordinary and efficacious remedies that surround them every day.

The action of the alkaloids and extracts that form the stock in trade of the present-day physician must necessarily differ from the action of the plants from which they are derived because applied to the patient in a different form and manner; therefore, the known properties of these alkaloids and extracts are not applied to the plants from which these extracts are taken. The properties listed here are those held for those plants by common repute, and are obtained from all the formularies, dispensaries and pharmacopœias within reach, without vouching for the accuracy of any.

The medicinal and therapeutic properties of the plants of Kansas must of necessity differ materially from those of the plants of Europe, grown in an entirely different climate. In addition to this, the number of practitioners who have made a specialty of studying the medicinal virtues of the plants of this state are very few. Prominent among these are Dr. J. H. Oyster, of Paola, Dr. W. S. Newlon, of Oswego, and Dr. L. E. Sayre, of the State University of Kansas. These gentlemen have, from time to time, published lists of the medicinal plants of the state, which lists have been freely consulted by the pres-

ent writer, who has compared the plants and their properties in these lists with those of the most eminent authorities on these subjects in the East, and availed himself freely of their use.

There are still other medicinal plants in the state that are not contained in this list; and it is hoped that further investigations may be made by our physicians, who may thereby discover something from which additional valuable alkaloids, extracts, oils, tinctures, etc., may be made.

New discoveries are being made continually. For instance, a few years ago the therapeutic value of echinacea, a plant common, if not abundant, in this state, was unknown. Now it is one of the most important drugs of the materia medica, and commands a high price. The price must rise as the demand increases, inasmuch as no efforts so far have been made for cultivating the plant.

A few cuts of some of the more important Western plants are inserted, to aid in identification. These are largely copied from Britton and Brown's Illustrated Flora of North America. A few are original.

It is hoped this crude list may yet prove of value.

1. Abronia fragrans. Sandflower. (See figure.) Western Kansas. Aperient.
2. Abutilon avicennæ. Velvet-leaf. Eastern Kansas. Abounds in mucilage, which it readily imparts to water. Antipyretic, demulcent, sedative.
3. Acalypha gracilens, A. virginica. Slender, three-seeded mercury. Eastern Kansas. Cathartic, sedative.
4. Acer dasycarpum, white maple; A. rubrum, red maple. Eastern Kansas. Astringent, colorant—the bark.
5. Acer saccharum. Sugar-maple. Extreme eastern Kansas. Nutritive.
6. Acerates longifolia, A. viridiflora. Milkweed. All over Kansas. Anthelmintic, diuretic.
7. Achillea millefolium. Yarrow. All over Kansas. Aromatic, astringent, diuretic, tonic.
8. Acorus calamus. Sweet flag. Northeast Kansas. Alterative, anthelmintic, cathartic, diuretic, emetic.

   Actinomeris—See Verbesina.
9. Adiantum pedatum. Maidenhair fern. Eastern Kansas. Expectorant, pectoral, refrigerant, tonic.
10. Adlumia cirrhosa. Allegheny vine. Eastern Kansas.
11. Æsculus glabra, Æ. parviflora. Buckeye. Eastern Kansas. Astringent, narcotic, tonic. Dangerous.
12. Agrimonia hirsuta, A. mollis, A. parviflora. Agrimony. Eastern Kansas. Alterative, astringent, tonic.
13. Ailanthus glandulosa. Tree of heaven. Introduced. Antipyretic.
14. Alisma plantago. Water plantain. All over Kansas. Antilithic, antispasmodic, narcotic, sedative.
15. Allium canadensis, A. cepa, A. reticulatum, etc. Onion. All over Kansas. Antherpetic, antiscorbutic, antiseptic, aperient, nutritive.
16. Amaranthus albus, white pigweed; A. spinosus, spiny pigweed. Eastern Kansas.

FIG. 1.
Abronia fragrans.

FIG. 2.
Amorpha canescens.

17. Ambrosia artemisiæfolia, ragweed; A. trifida, horseweed. Eastern Kansas. Anthelmintic.
18. Amelanchier canadensis. Juneberry. Northeast Kansas.
19. Amorpha canescens, shoestring (see figure); A. fruticosa, leadplant. All over Kansas. Strongly astringent.
20. Ampelopsis quinquefolia. Virginia creeper. Eastern and middle Kansas. Alterative, astringent, expectorant, tonic.
21. Amphiachyris dracunculoides. Eastern Kansas. Astringent, stimulant, tonic.
22. Amygdalus persica. Peach. Cultivated. Sedative, vulnerary—the leaves. Nutritive—the fruit.
23. Andropogon saccharatus. Silky bluestem. Southern Kansas.
24. Anemone caroliniana (see figure), A. Pennsylvanica. Anemone. Eastern and middle Kansas. Emmenagogue, pectoral, sedative.
25. Anthemis cotula. Mayweed. Introduced. Antipyretic, antispasmodic, diaphoretic, emetic, sedative, tonic.
26. Apium graveolens. Celery. Cultivated. Antilithic, antispasmodic, carminative, esculent, hypnotic, stimulant. The blanched leaves and seed have these properties in different degrees.
27. Apocynum androsæmifolium, dogbane; A. cannabinum, Indian hemp. Alterative, anthydropic, cathartic, diaphoretic, diuretic, emetic, expectorant, tonic.
28. Arabis canadensis. Sicklepod. Eastern Kansas.
29. Arctium lappa. Burdock. Introduced. Alterative, aperient, diaphoretic, diuretic.
30. Argemone alba. Prickly poppy. Western Kansas. Anthydropic, cathartic, diaphoretic, diuretic.
31. Arisæma dracontium, dragon-root; A. triphyllum, Indian turnip. Eastern Kansas. Anthydropic, diaphoretic, expectorant, rubefacient, vesicant.

FIG. 3.
Anemone caroliniana.

FIG. 4.
Artemisia filifolia.

32. Aristolochia sipho, Dutchman's pipe; A. tomentosa, birthwort. Eastern Kansas. Aromatic, antipyretic, emmenagogue.
33. Artemisia abrotanum, southernwood; A. absinthium, wormwood; A. dracunculoides, wild tarragon; A. filifolia, wild sage (see figure); A. frigida, mountain sage; A. ludoviciana, Garfield tea; A. vulgaris, mugwort. Anthelmintic, antipyretic, narcotic, stimulant, tonic.
34. Asclepias cornuti, silkweed; A. incarnata, swamp milkweed; A. verticillata, dwarf milkweed. All over Kansas. Anthelmintic, cathartic, diaphoretic, diuretic, expectorant.
35. Asclepias tuberosa. Butterfly weed, pleurisy root, rheumatism root. Common in Kansas. Astringent, diaphoretic, diuretic, expectorant.
36. Asimina triloba. Pawpaw. Eastern Kansas. Diuretic, emetic—the seeds. Esculent—the fruit.
37. Asparagus officinalis. Asparagus. Cultivated. Aperient, pectoral, nutritive.
38. Aster puniceus. Starflower. Eastern Kansas.
39. Astragalus crassicarpus. Prairie pea. All over Kansas. Pectoral—the fruit.
40. Astragalus mollissimus. Woolly loco (see figure). Said to affect the nerves of cattle and horses.
41. Baccharis salicina. Groundsel bush. Western Kansas. Is said to repel fleas and bugs.
42. Baptisia australis, B. leucantha, B. leucophea. Wild indigo. General in Kansas. Alterative, antipyretic, antiseptic, astringent, cathartic, emetic, tonic.

FIG. 5.
Astragalus mollissimus.

FIG. 6.
Batrachium trichophyllum.

42½. Batrachium trichophyllum. Water crowfoot (see figure). Western Kansas.

43. Benzoin odoriferum. Spice bush, fever bush. Extreme southeastern Kansas. Aromatic, stimulant, tonic.

44. Bidens bipinnata, B. connata, B. frondosa. General. Spanish needles, pitchforks. Emmenagogue, expectorant, tonic.

45. Botrychium virginicum. Rattlesnake fern. Eastern Kansas. Demulcent, tonic.

46. Brassica alba, white mustard; B. nigra, black mustard; B. oleracea, cabbage, cultivated and wild. Common. Esculent, laxative, tonic.

47. Brunella vulgaris. Self-heal. Common. Vulnerary.

48. Bumelia lanuginosa, B. lycioides. Southern buckthorn. Southeastern Kansas. Aperient.

49. Cacalia atriplicifolia, C. tuberosa. Indian plantain. General. Alterative —the root.

50. Cannabis sativa. Hemp. Introduced. Antispasmodic, narcotic, sedative.

51. Capsella bursapastoris. Shepherd's purse. Introduced. Common. Diuretic, stimulant, tonic.

52. Cassia chamæcrista. Sensitive pea. All over Kansas. Laxative, tonic.

53. Cassia marylandica. American senna. Eastern Kansas. Cathartic.

54. Catalpa bignonioides. Catalpa. Introduced.

55. Ceanothus americanus, Jersey tea; C. ovalis, red-root. General. Antispasmodic, antistrumatic, astringent, pectoral, sedative, tonic.

56. Celastrus scandens. Bittersweet. General. Alexipharmic, antherpetic, antiscorbutic, antiseptic, emetic, emollient, tonic.

57. Cephalanthus occidentalis. Button-bush. Eastern Kansas. Alterative, laxative, tonic.

58. Cerasus serotina, wild cherry; C. virginiana, choke-cherry. Eastern and middle Kansas. Expectorant, sedative, stimulant, tonic.

59. Cercis canadensis. Redbud. Eastern and southeastern Kansas. Alterative, astringent.

60. Chelone glabra. Snake-head, balmony. Eastern Kansas. Anthelmintic, antherpetic, laxative, tonic.

FIG. 7.
Echinocereus viridiflorus.

FIG. 8.
Engelmannia pinnatifida.

61. Chenopodium ambrosioides, Mexican tea; C. anthelminticum, wormseed; C. botrys, Jerusalem oak. Eastern Kansas and general. Anthelmintic, antispasmodic, stimulant.
62. Chrysanthemum leucanthemum. Oxeye daisy. Introduced. Alterative, tonic.
63. Cicuta maculata. Water hemlock. General. Alterative, antispasmodic, aperient, narcotic, sedative.
64. Citrullus vulgaris. Watermelon. Cultivated. Anthelmintic, demulcent, diuretic, nutritive.
65. Claviceps purpurea. Ergot of rye. On rye. Cult. Parturient.
66. Clematis viorna, leather-flower; C. virginiana, virgin's bower. Eastern and middle Kansas. Anticarcinic, diaphoretic, diuretic.
67. Cleome serrulata. Rocky mountain bee-flower. Western Kansas. Anthelmintic, antipyretic, tonic.
68. Cleomella angustifolia. Trail mustard. Western Kansas. Anthelmintic, tonic.
69. Cochlearia armoracia. Horseradish. Introduced. Antherpetic, antipyretic, diuretic, nutritive, rubefacient, stimulant—the root.
70. Conobea multifida. Conobea. Eastern Kansas. Alterative and tonic. (Doctor Oyster.)
71. Coreopsis tinctoria. Stickseed. Middle and western Kansas. Expectorant, tonic.
72. Cornus circinata, dogwood; C. sericea, kinnikinnik; C. stolonifera, red osier. Eastern Kansas. Astringent, tonic.
73. Corydalis aurea. Golden corydalis. General. Alterative, tonic.
74. Corylus americana. Hazel. Eastern Kansas. Astringent, nutritive.
75. Croton capitatus, C. monanthogynus, C. texensis. Crotons. General. Aperient, cathartic, diaphoretic, stimulant, vesicant.
76. Cucumis melo, muskmelon; C. sativa, cucumber. Cult. Astringent, diuretic, esculent, nutritive.

FIG. 9.
Gaillardia pulchella.

FIG. 10.
Grindelia ciliata.

77. Cucurbita pepo, pumpkin. Cult. Diuretic—the seeds. Nutritive—the fruit.
78. Cucurbita fœtidissima. Wild gourd. Western and middle Kansas. Anthelmintic, astringent, cathartic.
79. Cucurbita lagenaria. Gourd. Cult. Astringent, cathartic.
80. Cydonia vulgaris. Quince. Cult. Nutritive.
81. Cynoglossum officinalis, hound's tongue; C. morrisoni, beggar-ticks. Eastern Kansas. Astringent, demulcent, emollient.
82. Cypripedium parviflorum. Lady's slipper. Eastern Kansas. Antispasmodic, nervine, parturient.
83. Dalea aurea, D. jamesii, D. laxiflora. Western Kansas. Terebinthinate. Properties not yet learned.
84. Dalea lanata. Woolly dalea. Western Kansas. Cathartic, diuretic, stimulant.
85. Datura stramonium. Jimson. Eastern Kansas. Antispasmodic, demulcent, powerfully narcotic, sedative, emollient.
86. Delphinium carolinianum, D. tricorne. Larkspur. Eastern and middle Kansas. Anthelmintic, cathartic, diuretic, emmenagogue, emetic.
87. Dioscorea villosa. Wild yam. Eastern Kansas. Antispasmodic, demulcent, diaphoretic, emollient, expectorant, sedative.
88. Diospyros virginiana. Persimmon. Eastern Kansas. Antiseptic, astringent, colorant, tonic—the bark. Esculent—the fruit.
89. Ditaxis humilis, D. mercurialinus. Three-seeded mercury. Eastern Kansas. Cathartic, sedative.
90. Dodecatheon meadia. American cowslip. Eastern Kansas.
91. Draba caroliniana. Whitlow grass. General.
92. Dysodia papposa. Dog-fennel. General. Apparently introduced.
93. Echinacea angustifolia, nigger-head; E. purpurea, black Samson. Eastern and middle Kansas. Alterative.
94. Elephantopus carolinianus. Elephant's foot. Southeastern Kansas. Diaphoretic, emetic, expectorant.
95. Equisetum hyemale. Scouring rush. Common. Diuretic.
96. Erechtites hieracifolius. Fireweed. Introduced. Alterative, astringent, emetic, tonic.

FIG. 11.
Heliotropium convolvulaceum.

FIG. 12.
Hoffmanseggia jamesii.

97. Erigeron canadense, E. philadelphicum, E. strigosum. Fleabanes. Eastern and middle Kansas. Astringent, diaphoretic, diuretic, stimulant, tonic.
98. Eryngium aquaticum. Rattlesnake's master. Eastern Kansas. Alexipharmic, diaphoretic, diuretic, expectorant, stimulant.
99. Erythronium albidum. White adder-tongue. Eastern Kansas. Alterative, antiscorbutic—the leaves and corm.
100. Euonymus americanus, E. atropurpureus. Burning-bush, wahoo. Eastern Kansas. Alterative, antiperiodic, aperient, diuretic, tonic.
101. Eupatorium ageratoides, white snakeroot; E. perfoliatum, white boneset; E. purpureum, Joe Pye weed, queen of the meadow. Eastern Kansas. Antipyretic, aperient, diaphoretic, diuretic, emetic, expectorant, stimulant, tonic.
102. Euphorbia corollata, flowering spurge; E. marginata, snow-on-the-mountain. Eastern and middle Kansas. Anthydropic, astringent, diaphoretic, emetic, tonic, vesicant.
103. Euphorbia humistrata, milk pursley; E. hypericifolia, spurge; E. maculata, spotted spurge; E. serpens, milk pursley. Eastern Kansas. Astringent, diaphoretic, stimulant, tonic.
104. Fragaria vesca, F. virginiana. Strawberry. Eastern Kansas. Astringent, diuretic, esculent.
105. Fraxinus americana, white ash; F. viridis, green ash. Common. Alterative, diuretic, tonic.
106. Galium aparine, G. triflorum. Cleavers. Eastern Kansas. Antiscorbutic aperient, diuretic, refrigerant.
107. Gaura biennis, G. filipes, G. sinuata, G. villosa. Gaura. Mostly wester Kansas. Astringent, emollient, vulnerary.
108. Gentiana andrewsii, closed gentian; G. puberula, downy gentian. Easte to central Kansas. Tonic.

FIG. 13.
Lacinaria pycnostachya.

FIG. 17.
Lippia cuneifolia.

109. Geranium carolinianum, G. maculatum. Geranium. Eastern Kansas. Astringent.
110. Geum canadense, white avens; G. virginianum, rough avens. Eastern Kansas. Astringent, tonic.
111. Glycyrrhiza lepidota. Wild liquorice, bur pea. Common. Emollient, pectoral—the root.
112. Gnaphalium obtusifolium. Sweet life-everlasting. Central Kansas. Astringent.
113. Gossypium herbaceum. Cotton. Cultivated in southeastern Kansas.
114. Grindelia ciliata (see figure), G. squarrosa. Gum plant. General. Antispasmodic, sedative.
115. Gymnocladus canadensis. Coffee-bean. Eastern and middle Kansas.
116. Hedeoma hispida. American pennyroyal. Eastern and middle Kansas. Aromatic, diaphoretic, stimulant.
117. Helenium autumnale. Sneezewort. Eastern Kansas. Antipyretic, errhine.
118. Heliotropium convolvulaceum. Sandhill heliotrope. Southwestern Kansas.
119. Helianthemum canadense, H. majus. Rock rose. Southeast Kansas. Alterative, antiscorbutic, astringent, tonic.
120. Helianthus annuus, sunflower, all over Kansas; H. decapetalus, sunflower, eastern Kansas; H. orgyalis, rock sunflower, eastern Kansas; H. petiolaris, sandhill sunflower, middle and western Kansas. Antipyretic, diuretic, expectorant, pectoral.
120*b*. Helianthus tuberosus. Artichoke. General. Esculent.
121. Heuchera hispida, alum-root. Eastern Kansas. Antiseptic, astringent, styptic.
122. Hicoria alba, mockernut; H. glabra, pignut; H. minima, bitternut; H. ovata, shagbark hickory; H. sulcata, big shellbark. All eastern Kansas. Antipyretic, aromatic, astringent, pectoral—the bark. Esculent—the fruit.

FIG. 14.
Lacinaria spicata.

FIG. 15.
Lepachys tagetes.

123. Hieracium longipilum. Hawkweed. Eastern Kansas. Alterative, tonic.
124. Hoffmanseggia jamesii (see figure). Western Kansas.
125. Hordeum distichum. Barley. Cult. Esculent.
126. Humulus lupulus. Hop. Eastern Kansas. Anthelmintic, antilithic, antiphrodisiac, antipyretic, diuretic, hypnotic, tonic. Food for birds—the seed.
127. Hydrastis canadensis. Golden seal. Northeastern Kansas. Antipyretic, aperient, cholagogue, tonic.
128. Hypericum maculatum. St.-John's-wort. Astringent, diuretic, sedative, stimulant.
129. Ilex decidua. Northern holly. Southern Kansas. Diuretic, tonic.
130. Impatiens fulva, I. pallida. Touch-me-not, balsam-weed. Eastern Kansas. Emollient, vulnerary.
131. Indigofera leptocephala. Western Kansas.
132. Ipomœa leptophylla, I. pandurata. Man-of-the-earth. Western Kansas. Cathartic, diuretic.
133. Juglans cinerea. Butternut. Northeast Kansas. Laxative, vesicant, colorant, esculent.
134. Juglans nigra. Black walnut. All over Kansas. Astringent, vulnerary, colorant—the bark and hulls of the fruit. Esculent—the fruit.
135. Juniperus virginiana. Red cedar. Eastern Kansas. Diaphoretic—the berries. Kuhnistera (see Petalostemon).
136. Lacinaria pycnostachya, rattlesnake-root (see figure); L. scariosa, gay feather; L. spicata, button-snakeroot (see figure); L. squarrosa, blazing star. General. Alexipharmic, astringent, carminative, diaphoretic, diuretic, hypnotic, sedative, stimulant.
137. Lactuca canadensis. Wild lettuce. General. Hypnotic, sedative, esculent. Lappa (see Arctium).
138. Leonurus cardiaca. Motherwort. Eastern Kansas. Antispasmodic, diaphoretic, emmenagogue, laxative, nervine, parturient, tonic.
139. Lepachys tagetes (see figure). Western Kansas.
140. Lepidium virginicum. Tongue-grass. Eastern Kansas. Carminative, esculent.
141. Leptandra virginica. Culver's physic. Eastern Kansas. Alterative, cathartic, cholagogue, tonic.

FIG. 16.
Leucelene ericoides.

FIG. 18.
Lithospermum angustifolium.

142. Lespedeza capitata. Bush clover. General. Diuretic, emetic.
Leucanthemum vulgare (see Chrysanthemum).
Liatris (see Lacinaria).
143. Linaria vulgaris. Butter-and-eggs, toad flax. Introduced. Antherpetic, anthydropic, antinephritic.
144. Linum rigidum, prairie flax; L. sulcatum, yellow flax; L. usitatissimum, flax. General. Demulcent, emollient, tonic.
145. Lithospermum angustifolium (see figure); L. canescens. Stone-seed. Eastern Kansas or general.
146. Lobelia cardinalis, cardinal flower; L. inflata, puke-weed; L. syphilitica, great lobelia. General, though not common. Anthelmintic, antispasmodic, antisyphilitic, cathartic, diaphoretic, diuretic, emetic, expectorant, narcotic.
147. Lycium barbarum. Matrimony vine. Introduced.
148. Lycoperdon giganteum. Puff-ball. General. Styptic.
149. Lycopersicum esculentum. Tomato. Cult. Antiscorbutic, vulnerary.
150. Lycopus sinuatus, water hoarhound; L. virginicus, bugle-weed. Eastern Kansas. Antipyretic, astringent, colorant, narcotic, sedative, tonic.
151. Lysimachia quadrifolia. Eastern Kansas.
152. Lythrum alatum. Loosestrife. General.
153. Malus coronaria, crab-apple; M. sylvestris, apple. Cult. or eastern Kansas. Antipyretic, nutritive.
154. Malva rotundifolia. Low mallow. Introduced. Astringent, demulcent, emollient.
155. Marrubium vulgare. Hoarhound. Introduced. Expectorant, laxative, tonic.
156. Maruta cotula (see Anthemis cotula).
157. Melilotus alba, sweet clover; M. officinalis, yellow sweet clover. Introduced. Antispasmodic, laxative, sedative, stimulant. Produces headache in horses and cattle.
158. Menispermum canadense. Moonseed. Eastern Kansas. Alterative, diuretic, laxative, tonic—the root.
159. Mentha canadensis, field mint; M. piperita, peppermint; M. viridis, spearmint. Eastern Kansas. Antipyretic, antispasmodic, carminative, stimulant.
160. Mertensia virginica. Smooth lungwort. Eastern Kansas. Pectoral.

FIG. 19.
Pentstemon cobæa.

FIG. 20.
Phlox bryoides.

161. Micrampelis lobata. Wild cucumber. Eastern Kansas. Vesicant.
162. Molucella lævis. Molucca balm. Cultivated. Antipyretic.
163. Momordica balsamina. Balsam apple. Cultivated. Vulnerary.
164. Monarda citriodora, lemon mint; western Kansas. M. fistulosa, wild bergamot; eastern Kansas. M. punctata, horsemint; western Kansas. Aromatic, carminative, diaphoretic, stimulant, tonic.
165. Monotropa uniflora. Indian pipe. Eastern Kansas. Antispasmodic, nervine, sedative, tonic.
166. Morus rubra. Mulberry. Eastern Kansas. Astringent.
167. Nabalus asper. Rattlesnake weed. Eastern Kansas. Alexipharmic.
168. Nelumbo lutea. Yonkopin, pond lily. Eastern Kansas.
169. Nepeta cataria. Catnip. Introduced. Carminative, diaphoretic, stimulant, tonic.
170. Nicotiana tabacum. Tobacco. Cultivated. Diuretic, emetic, narcotic, sedative.
171. Nuphar advena. Yellow pond lily. Eastern Kansas. Astringent, demulcent, sedative.
172. Œnothera biennis, Œ. fremonti, Œ. missouriensis. Evening primrose. General. Alterative, astringent, demulcent—the root.
173. Onosmodium carolinianum, O. molle, O. virginianum. Wild comfrey. General. Demulcent, diuretic, emollient.
174. Osmorrhiza brevistyla, O. longistyla. Sweet cicely. Carminative, expectorant, stimulant.
175. Ostrya virginica. Ironwood. Eastern Kansas. Alterative, antiperiodic, tonic.
176. Oxalis stricta, O. violacea. Wood sorrel. Eastern Kansas. Anticarcinic.
177. Oxytropis lamberti. Loco. Western Kansas. Is said to affect the nerves of horses and cattle.
178. Paronychia jamesii. Nailwort. Western Kansas. Reputed for whitlow.
179. Parthenium integrifolium. Prairie feverfew. Eastern Kansas. Antipyretic, diuretic, tonic, insectifuge.
180. Passiflora incarnata. Passion-flower. Eastern Kansas. Hypnotic.
181. Penthorum sedoides. Virginia stone-crop. Eastern Kansas. Astringent, demulcent, pectoral.

FIG. 21.
Polanisia graveolens.

FIG. 22.
Townsendia grandiflora.

182. Pentstemon cobæa. Pentstemon (see figure). General. Alterative, cathartic, emetic.
183. Pæonia officinalis. Peony. Cult. Emmenagogue.
Persica (see Amygdalus persica).
184. Petalostemon candidus, P. multiflorus, P. villosus, P. violaceus. Prairie clovers. General. Cathartic, stimulant. Not well known.
185. Petroselinum sativum. Parsley. Cult. Anthydropic, antinephritic, carminative, diuretic, laxative.
186. Peucedanum fœniculaceum. Fennel-leaf parsnip. Eastern Kansas. Carminative, stimulant.
187. Phalaris canariensis. Canary grass. Cult. Food for birds—the seed.
188. Phoradendron flavescens. Mistletoe. Southeastern Kansas. Antispasmodic, laxative, parturient.
189. Physalis lanceolata, P. philadelphica, P. pubescens, P. virginiana. Ground cherry. Diuretic.
190. Phytolacca decandra. Pokeberry. Eastern Kansas. Alterative, antherpetic, emetic, hypnotic, laxative, sedative, vulnerary—the root. Colorant—the ripe berries.
191. Pilea pumila. Richweed. Eastern Kansas. Antipyretic, vulnerary—the bruised leaves.
192. Plantago major, dooryard plantain; P. lanceolata, tall plantain. Introduced. Alexipharmic, alterative, antiseptic, diuretic, vulnerary.
193. Platanus occidentalis. Sycamore. Eastern Kansas. Carminative—the buds.
194. Podophyllum peltatum, May-apple. Alterative, cathartic, cholagogue—the root. Nutritive, cathartic—the fruit.
195. Polanisia graveolens (see figure), P. uniglandulosa. Gravel weed. Western Kansas. Anthelmintic, cathartic, tonic.
196. Polygala alba, P. incarnata, P. polygama, P. senega. Seneca snakeroot. General, except P. senega, which is also reported, though rarely seen. Alexipharmic, alterative, cathartic, diaphoretic, diuretic, emetic, emmenagogue, expectorant, stimulant. These properties belong mostly to P. senega; the other species, though more common here, are l known.

197. Polygonatum biflorum, P. giganteum. Solomon's seal. Eastern Kansas. Astringent, demulcent, tonic, vulnerary.
198. Polygonum amphibium, water tannin-plant; P. hartwrighti, tannin-plant; P. hydropiper, water-pepper; P. persicaria, lady's thumb; P. puncatum, smartweed. Some of these species are common everywhere in the state. Antiseptic, diaphoretic, diuretic, emmenagogue, stimulant, vesicant.
199. Polymnia uvedalia. Leaf cup. Southeastern Kansas. Aperient, sedative.
200. Polypodium vulgare. Rock polypod. Eastern Kansas. Expectorant, pectoral.
201. Polytænia nuttallii. Wild parsnip. General. Carminative, stimulant. Poisonous to cows.
202. Populus monilifera. Cottonwood. General. Antipyretic, tonic.
203. Portulaca oleracea. Purslane. Common, apparently native. Diuretic, refrigerant.
204. Potentilla canadensis. Cinquefoil. Eastern Kansas. Astringent, tonic.
Prinos (see Ilex).
205. Prunus americana, plum; P. angustifolia, sandhill plum; P. chicasa, Chickasaw plum. General. Astringent, sedative, tonic—the bark. Nutritive—the fruit.
Prunus persica (see Amygdalus).
Prunus serotina, P. virginiana (see Cerasus).
206. Psoralea argophylla, silvery leather-root; P. floribunda, P. tenuiflora, leather-root. General. Cathartic, nervine.
207. Psoralea esculanta, P. hypogæa. Indian breadroot. General. Esculent.
208. Psoralea pedunculata. Samson's snakeroot. Central Kansas.
209. Ptelea trifoliata. Hop tree, shrub trefoil. Eastern Kansas. Tonic.
210. Pycnanthemum lanceolatum, basil; P. linifolium, P. pilosum, mountain mint. Eastern Kansas. Diaphoretic, emmenagogue, stimulant, tonic.
211. Pyrus communis. Pear. Cultivated. Antipyretic, tonic—the bark. Esculent, nutritive—the fruit.
Pyrus malus (see Malus).
212. Quercus alba, white oak; Q. aquatica, water oak; Q. coccinea, scarlet oak; Q. macrocarpa, bur oak; Q. palustris, swamp oak; Q. prinoides, chestnut oak; Q. stellata, post oak; Q. tinctoria, yellow oak. Eastern Kansas. Astringent, tonic, colorant—the inner bark.
213. Ranunculus acris, blister cup; R. aquatilis, water crowfoot; R. repens, creeping crowfoot; R. sceleratus, ditch crowfoot. Eastern Kansas. Carminative, rubefacient, vesicant.
214. Rhamnus lanceolata. Buckthorn. Eastern Kansas. Violent cathartic.
215. Rheum rhaponticum. Rhubarb. Cultivated. Astringent, cathartic, esculent, tonic.
216. Rhus glabra, sumach; R. radicans, climbing ivy; R. trilobata, scented sumach. Eastern Kansas. Antiseptic, astringent, diuretic, refrigerant, tonic, vesicant.
217. Rhus toxicodendron. Poison oak. Southeastern Kansas. Diaphoretic, diuretic, hypnotic, rubefacient, stimulant, tetanic, vesicant.
218. Ricinus communis. Castor-bean. Cultivated. Cathartic.
219. Robinia pseudacacia. Black locust. Introduced.
220. Rosa lucida: R. setigera. Rose. Eastern Kansas.
221. Rubus canadensis, blackberry; R. strigosus, raspberry; R. trivialis, dewberry; R. villosus, blackberry. Eastern Kansas and cultivated. Astringent, tonic, esculent.

222. Rudbeckia laciniata. Thimble weed. Eastern Kansas. Antinephritic, antilithic.
223. Rumex acetosella, field sorrel; R. crispus, curly dock, yellow dock; R. salicifolius, pale dock. Eastern Kansas, or introduced. Alterative, astringent, aperient, tonic—the root.
224. Salix fragilis, brittle willow; S. nigra, black willow. Eastern Kansas. Antipyretic, antiseptic, astringent, tonic—the bark.
225. Salvia azurea, blue sage; S. officinalis, sage; S. pitcheri, tall blue sage. General or cultivated. Aromatic, astringent, diaphoretic, stimulant, tonic—the leaves and flowers.
226. Sambucus canadensis. Elder. Eastern Kansas. Alterative, aperient, diaphoretic, diuretic, emetic, hypnotic, pectoral, sedative, stimulant.
227. Sanguinaria canadensis. Bloodroot. Eastern Kansas. Alterative, diaphoretic, emetic, narcotic, sedative, stimulant, tonic.
228. Sanicula marylandica. All-heal. Eastern Kansas. Alexipharmic, antipyretic, antispasmodic, diaphoretic, nervine, tonic.
229. Sapindus marginatus. Soapberry. Southern Kansas. Alterative, tonic—the bark and berries.
230. Saponaria officinalis. Soapwort, bouncing bet. Cultivated. Alterative, diuretic, tonic.
231. Sassafras officinale. Sassafras. Southeastern Kansas. Alterative, antiseptic, diaphoretic, stimulant, aromatic.
232. Scrofularia nodosa. Figwort. Eastern Kansas. Alterative, vulnerary.
233. Scutellaria lateriflora, S. parvula. Skullcap. Eastern Kansas. Antispasmodic, nervine, tonic.
234. Secale cereale. Rye. Cultivated. Esculent.
235. Sedum pulchellum. Stonecrop. Antiseptic, astringent.
236. Senecio aureus. Squaw-weed, life-root. Middle and western Kansas. Alterative, diaphoretic, diuretic, emmenagogue, parturient, pectoral, tonic.
237. Seymeria macrophylla. Mullein foxglove. Eastern Kansas. Alterative, tonic.
238. Sicyos angulatus. Bur cucumber. Eastern Kansas. Astringent, cathartic, vesicant.
239. Sida spinosa. Prickly sida. Eastern Kansas. Anthelmintic, emollient.
240. Silphium laciniatum, compass plant; S. perfoliatum, cup plant; S. terebinthinaceum, rosinweed. Antipyretic, diuretic, emetic, expectorant, tonic.
241. Sinapis alba, S. nigra. Mustard. Introduced. Vesicant.
242. Sisymbrium officinale. Hedge mustard. Introduced. Diuretic, expectorant.
243. Smilax glauca, smooth greenbrier; S. rotundifolia, greenbrier; S. pseudochina, wild cinnamon vine. Eastern Kansas. Alterative, aperient, emetic.
244. Solanum carolinense, horse nettle; S. nigrum, nightshade. Eastern Kansas or introduced. Alexipharmic, anticarcinic, antiscorbutic, vulnerary.
245. Solanum tuberosum. Potato. Cult. Esculent, nutritive—the tubers.
246. Solidago canadensis, S. gigantea, S. rigida, S. serotina, S. tenuifolia. Goldenrod. General. Carminative, diaphoretic, stimulant.
247. Sorghum saccharum. African sugar-cane. Cult. Demulcent, nutritive.
248. Spiræa tomentosa. Hardhack, meadow sweet. Eastern Kansas. Astringent, tonic.
249. Staphylea trifolia. Bladdernut. Eastern Kansas. Emetic, stimulant.

FIG. 23.
Zinnia grandiflora.

250. Stenosiphon virgatus. Western Kansas. Properties the same as in Gaura. Stramonium (see Datura).
251. Stylosanthes elatior. Pencil flower. Southeastern Kansas. Sedative, tonic.
252. Symphoricarpus vulgaris. Coral-berry, buck-bush. General. Astringent.
253. Tanacetum vulgare. Tansy. Introduced. Anthelmintic, aromatic, astringent, diaphoretic, emmenagogue, tonic, vulnerary.
254. Taraxacum officinale. Dandelion. Introduced. Alterative, aperient, cholagogue, diaphoretic, diuretic, nutritive, tonic.
255. Tephrosia virginica. Goat's rue. Eastern Kansas. Cathartic.
256. Teucrium canadense. Wood sage. General. Stimulant.
257. Thaspium aureum. Meadow parsnip. Eastern Kansas. Astringent, carminative, stimulant, narcotic.
258. Thuja occidentalis. Arbor vitæ. Cult. Anthelmintic, diuretic, emmenagogue, stimulant.
259. Tilia americana. Basswood. Eastern Kansas. Demulcent, diaphoretic, emollient, stimulant, vulnerary — the bark and buds.
260. Trifolium arvense, stone clover; T. pratense, red clover; T. reflexum, buffalo clover; T. repens, white clover. Eastern Kansas or introduced. Alterative, anticarcinic, antispasmodic, aperient, emollient, nervine, sedative.
261. Trillium erectum. Birthroot. Eastern Kansas. Antiseptic, astringent, emetic, parturient, tonic.
262. Triosteum perfoliatum. Feverwort. Eastern Kansas. Alterative, antipyretic, cathartic, emetic.
263. Triticum vulgare. Wheat. Cult. Esculent.
264. Typha latifolia. Cat-tail. Eastern Kansas. Astringent, emollient.
265. Ulmus fulva. Slippery elm. General. Demulcent, emollient, nutritive.
266. Urtica dioica, U. urens. Nettle. Eastern Kansas. Astringent, diuretic, styptic, tonic.
267. Ustilago maidis. Corn smut. General. Emmenagogue, parturient.
268. Verbascum thapsus. Mullein. Introduced. Antispasmodic, demulcent, diuretic, emollient, hypnotic, pectoral, sedative.
269. Verbena angustifolia, narrow-leaved verbena; V. aubletia, low verbena; V. hastata, verbena; V. urticæfolia, white verbena. General. Diaphoretic, emetic, expectorant, tonic.

270. Verbesina encelioides. V. helianthoides. Crownbeard. Eastern Kansas. Antinephritic, diuretic.
271. Vernonia fasciculata, V. noveboracensis. Ironweed. Eastern Kansas. Alterative, tonic.

Veronica virginica (see Leptandra).

272. Viburnum prunifolium. Black haw. Eastern Kansas. Antipyretic, antiseptic, astringent.
273. Viola pedata. Birdfoot violet. Eastern Kansas. Alterative, antherpetic, emollient, vulnerary.
274. Vitis cordifolia, grape; V. estivalis, summer grape; V. riparia, river grape; V. vulpina, fox grape. General. Esculent, nutritive, tonic.
275. Xanthium strumarium. Cockle-bur. Eastern Kansas, or introduced. Alexipharmic, diuretic, styptic.
276. Xanthoxylum americanum. Prickly ash. Eastern Kansas. Alterative, antispasmodic, carminative, diuretic, expectorant, rubefacient, stimulant, tonic—the berries and bark.
277. Yucca angustifolia. Soaproot. Western Kansas. Cleanliness is the first step to health.
278. Zea mays. Indian corn. Cultivated. Esculent.
279. Zizia aurea. Golden parsnip. Eastern Kansas. Carminative, stimulant, narcotic.
280. Zygadenus elegans, Z. nuttallii. Wild hyacinth. Eastern Kansas. Cathartic, emetic, narcotic.

ADDITIONAL.

281. Agropyron repens. Couch grass. Common.
282. Asarum canadense. Wild ginger. Eastern Kansas.
283. Asclepiodora decumbens. Decumbent milkweed. Common.
284. Batrachium trichophyllum. Water crowfoot (see figure). Western Kansas.
285. Chionanthus virginica. Fringe tree. Cherokee county.
286. Cichorium intybus. Chicory. Northeastern Kansas; introduced.
287. Comandra umbellata. Comandra. Common.
288. Daucus carota. Wild carrot, Queen Anne's lace. Eastern Kansas; introduced.
289. Dioscorea villosa. Wild yam-root. Bourbon county.
290. Echinocereus viridiflorus. Green-flowered cactus (see figure). Southwestern Kansas.
291. Engelmannia pinnatifida (see figure). Western Kansas.
292. Gaillardia pulchella (see figure). Western Kansas.
293. Gleditschia triacanthos. Honey-locust. Eastern Kansas, and introduced west.
294. Heracleum lanatum. Cow-parsnip. Southeastern Kansas.
295. Inula helenium. Elecampane. Eastern Kansas; introduced.
296. Iris versicolor. Large blue flag. Eastern Kansas.
297. Krameria secundiflora. Krameria. Southeastern Kansas.
298. Leucelene ericoides (see figure). Western Kansas.
299. Lippia cuneifolia (see figure). Eastern and middle Kansas.
300. Mentha spicata. Peppermint. Eastern Kansas; introduced.
301. Pastinaca sativa. Wild parsnip. Eastern Kansas.
302. Phlox bryoides. Moss phlox (see figure). Western Kansas.
303. Pulsatilla hirsutissima. Pasque-flower. Southeastern Kansas.
304. Sabbatia campestris. Prairie sabbatia. Southern Kansas.

305. Sophora sericea. Silky sophora. Western Kansas. One of the many "loco" weeds.

306. Townsendia grandiflora (see figure). Western Kansas.

307. Zinnia grandiflora. Great-flowered Zinnia (see figure). Southwestern Kansas.

INDEX TO THERAPEUTIC PROPERTIES.

Alexipharmic: 98, 136, 167, 192, 196, 228, 244, 275.

Alterative: 8, 12, 20, 27, 29, 42, 49, 56, 57, 59, 62, 63, 70, 93, 96, 100, 105, 119, 123, 141, 158, 172, 175, 182, 190, 192, 194, 196, 223, 226, 227, 229, 230, 231, 232, 236, 237, 243, 254, 260, 262, 271, 273, 276.

Anthelmintic: 6, 8, 17, 33, 34, 60, 61, 64, 67, 68, 78, 86, 126, 195, 239, 258.

Antherpetic: 15, 56, 60, 69, 143, 190, 273.

Anthydropic: 27, 30, 31, 102, 143, 185.

Anticarcinic: 66, 176, 244, 260.

Antilithic: 14, 26, 126, 222.

Antinephritic: 143, 185, 222, 270.

Antiperiodic: 100, 175.

Antipyretic: 2, 13, 25, 32, 33, 42, 67, 69, 101, 117, 122, 126, 127, 150, 153, 159, 162, 179, 191, 202, 211, 228, 240, 262, 272.

Antiscorbutic: 15, 56, 100, 119, 149, 244.

Antiseptic: 15, 42, 56, 88, 121, 192, 198, 216, 231, 235, 261, 272.

Antispasmodic: 25, 26, 50, 55, 61, 63, 82, 85, 87, 114, 138, 157, 159, 165, 188, 228, 233, 260, 268, 276.

Aperient: 1, 29, 37, 48, 75, 100, 101, 106, 127, 199, 223, 226, 243, 254, 260.

Astringent: 4, 7, 11, 12, 19, 20, 21, 35, 42, 55, 59, 72, 74, 76, 78, 79, 81, 88, 96, 97, 102, 103, 104, 107, 109, 110, 112, 119, 121, 122, 128, 134, 136, 150, 154, 166, 171, 172, 181, 197, 204, 205, 212, 215, 216, 221, 223, 225, 235, 238, 248, 250, 252, 253, 257, 261, 264, 266, 272.

Carminative: 26, 136, 140, 159, 164, 169, 174, 185, 186, 193, 201, 213, 246, 257, 276, 279.

Cathartic: 3, 8, 27, 30, 34, 53, 75, 78, 84, 86, 89, 132, 141, 182, 184, 194, 195, 196, 206, 214, 215, 218, 238, 255, 262, 280.

Cholagogue: 127, 141, 194, 254.

Colorant: 4, 88, 150, 190, 212.

Demulcent: 2, 45, 64, 81, 85, 87, 144, 154, 171, 172, 173, 181, 197, 247, 259, 265, 268.

Diaphoretic: 25, 27, 29, 30, 31, 34, 35, 66, 75, 87, 97, 98, 101, 102, 103, 116, 135, 136, 138, 164, 169, 196, 198, 210, 217, 225, 226, 227, 228, 231, 236, 246, 253, 254, 259, 268.

Diuretic: 6, 7, 8, 27, 29, 30, 34, 35, 36, 51, 64, 66, 69, 76, 77, 84, 86, 95, 97, 98, 100, 101, 104, 105, 106, 126, 128, 129, 132, 136, 142, 158, 170, 172, 179, 185, 189, 192, 196, 198, 203, 216, 217, 226, 230, 236, 240, 242, 254, 258, 266, 268, 270, 275.

Emetic: 8, 25, 27, 36, 42, 56, 86, 96, 101, 102, 142, 170, 182, 190, 196, 226, 227, 240, 243, 249, 261, 262, 268, 280.

Emmenagogue: 24, 32, 44, 86, 138, 183, 196, 198, 210, 236, 253, 254, 258, 267.

Emollient: 56, 81, 85, 87, 107, 111, 130, 144, 154, 173, 239, 250, 259, 260, 264, 265, 268, 273.

Esculent: 26, 36, 46, 76, 88, 104, 120*b*, 122, 125, 134, 137, 207, 211, 215, 221, 234, 245, 263, 274, 278.

Expectorant: 8, 9, 20, 27, 31, 34, 35, 44, 58, 71, 87, 98, 101, 155, 174, 196, 200, 240, 242, 268.

Hypnotic: 126, 136, 137, 180, 190, 217, 226, 268.

Insectifuge: 25, 41, 92, 179.

Laxative: 46, 52, 57, 60, 133, 138, 155, 157, 158, 185, 188, 190.
Narcotic: 11, 14, 33, 50, 63, 85, 150, 169, 170, 227, 257, 279, 280.
Nervine: 40, 82, 138, 177, 206, 228, 233, 260.
Nutritive: 5, 15, 22, 37, 64, 69, 74, 76, 77, 80, 122, 125, 126, 133, 153, 205, 234, 245, 247, 254, 263, 265, 274, 278.
Parturient: 65, 82, 138, 188, 236, 261, 267.
Pectoral: 24, 37, 39, 55, 111, 122, 160, 181, 200, 226, 236, 268.
Refrigerant: 9, 106, 203, 216.
Rubefacient: 31, 69, 213, 217, 276.
Sedative: 2, 3, 22, 24, 25, 50, 55, 58, 63, 85, 87, 89, 114, 128, 136, 137, 150, 157, 171, 190, 199, 205, 226, 227, 251, 260, 268.
Styptic: 121, 148, 266, 275.
Tetanic: 217.
Tonic: 7, 9, 11, 12, 20, 21, 25, 27, 33, 42, 43, 44, 45. 46, 51, 52, 55, 56, 57, 58, 60, 62, 67, 68, 70, 71, 72, 88, 96, 97, 100, 101, 102, 103, 105, 108, 110, 119, 123, 126, 127, 129, 138, 141, 144, 150, 155, 158, 164, 165, 169, 175, 179, 195, 197, 202, 204, 205, 209, 210, 211, 212, 215, 216, 221, 223, 224, 225, 227, 229, 230, 233, 236, 237, 240, 248, 251, 253, 254, 261, 266, 269, 271, 274, 276.
Vesicant: 31, 102, 161, 198, 213, 216, 217, 238, 241, 259.
Vulnerary: 22, 48, 107, 130, 134, 149, 163, 190, 191, 192, 197, 232, 244, 250, 253, 273.

V.

MISCELLANEOUS PAPERS.

"The Drying-up of Pools and Streams in Central Kansas."
By S. G. Mead, McPherson.

"Origin of Names of Kansas Streams."
By J. R. Mead, Wichita.

"Loss of Teeth as a Disqualification for Military Service."
By Edward Bumgardner, Lawrence.

"On Certain Methods of the Geometry of Position."
By Arnold Emch, Boulder, Colo.

"The Eleven-and-one-half-inch Equatorial Telescope at Washburn College Observatory."
By H. L. Woods, Washburn College, Topeka.

"Review of the Crop Season of 1902."
By T. B. Jennings, Topeka.

THE DRYING-UP OF POOLS AND STREAMS IN CENTRAL KANSAS.

By S. G. Mead, McPherson, Kan.

Read before the Academy, at Iola, December 31, 1901.

BEFORE the prairies of central Kansas were cultivated, they were covered by a scanty coat of native grasses, while the soil, hardened by the tramping of myriads of buffalo for uncounted centuries, was almost water-proof. The low places, the draws and creeks, the outlets of pools and lakes, were generally choked with a heavy growth of coarse vegetation. To saturate the hard-packed soil required but little water, of which the light covering of vegetation absorbed but slowly only a small portion. Much of the rainfall remained upon the surface, finding its way between the clumps of prairie-grass to the hollows and low places. From these it trickled slowly through the thick vegetation until it formed small creeks and streams, and so finally reached the rivers. Sometimes an exceptionally heavy rain would cause a flood for a short time, but this did not materially change the situation.

The advent of cultivation has practically changed the whole course of nature. The soil, pulverized by the plow and harrow, readily absorbs many times as much water as the unbroken sod, and the heavy crops—corn, wheat, etc.—draw from the ground a great excess over the amount of water needed by the native grasses. Many of the shallower pools disappeared at once, while others were much reduced in area. The farmers plowed up more and more of these small basins every year, thus increasing the water-absorbing area and diminishing the amount of water which reached the pools and creeks.

With the construction of public highways came an enormously increased absorption of water. While the roads themselves occupy less than three per cent. of the surface, there is quite an area which drains into them; but, except in cases of immense downpours or of long-continued rains, none of this water ever reaches the streams. In dry weather the ground in central Kansas cracks to the depth of several feet, and these cracks are quite large. I have seen them nearly three inches across and so numerous that it was not easy to find a square foot of surface without one.

These cracks appear in great numbers in the side ditches of the roads. How far they extend under the soil on each side can only be estimated. In all probability they connect with those in the fields, and thus may be said to extend indefinitely. The amount of water

required to fill these and to saturate the adjacent soil is enormous. Some idea of the flow can be gained from the fact that in many places the water running down forms small whirlpools which wash out holes several inches in diameter and sometimes a foot deep. I have seen them so numerous in side ditches that there would be six or eight to every rod on each side of the road.

During exceptional rains, when there is a flow of water, the wash from the plowed ground settles in the low places, fills up the old beds of streams, and thus still further carries on the work. To show how great a change has taken place in few years a number of instances may be cited. Some miles northeast of McPherson there is a bridge. The opening beneath it was six feet wide and six feet deep. It barely sufficed to carry off the flood-water when built. To-day the opening under the bridge is entirely filled up; the little flood-water which comes down the slope where the creek formerly ran flows across the road; there is never enough to make trouble. There are several places where there were swimming-holes "over your head" which now bear good crops of wheat every year. Good fishing-holes have entirely disappeared. The Santa Fe railroad, just west of McPherson, goes nearly a mile out of its course to avoid the basin. If the constructors had known what they know now they would have built it directly through. How long this process will go on it is impossible to say; at present it works very slowly, and has apparently nearly spent its force; in fact, there is very little left for it to do.

But what becomes of the water which formerly ran off? Much is absorbed at once by the soil, from which the roots of the growing crops take it very rapidly, so that, unless the rain is very heavy or long continued, there is none to flow off. And when there is a flow, that which reaches the side ditches of the roads sinks down and becomes a part of the ground-water which, in long dry spells, gradually rises to the surface and helps to save the farmers' crops.

The drying-up of pools and streams is a natural consequence of the processes of civilization. It is not an evil, but a positive benefit. The water no longer runs off to the great rivers, but is retained in the soil, and sooner or later accomplishes its mission of increasing the general yield of the soil.

ORIGIN OF NAMES OF KANSAS STREAMS.

By J. R. MEAD, Wichita, Kan.

Read before the Academy, at Iola, December 31, 1901.

THE origin of the names borne by some of our Kansas streams is well known; others are unknown or uncertain. Of a few of them I have personal knowledge.

The "Kaw" or "Kansas" derived its name from the tribe of Indians found living along its banks.

The "Saline" from the character of its water.

The "Smoky Hill" from the prominent isolated buttes within the great bend, landmarks widely known, to be seen from a great distance through an atmosphere frequently hazy from smoke.

The above names were given by plainsmen and explorers prior to the settlement of Kansas, and were probably known by the same names by the Indians, using words expressing the same meaning.

How the "Solomon" obtained its peculiar name is unknown to the writer. We have no account of King Solomon visiting Kansas.

In 1859 the writer, desiring to explore the Saline river, at that time almost unknown, sought information from Col. Wm. A. Phillips, who had recently staked out the town of Salina. He referred me to his brother-in-law, a young man named Spillman, who had been up the river forty miles to a large tributary from the north, miry and difficult to cross on account of salt marshes near its mouth. We arrived at this stream late at night and in the dark drove into a miry bog. I remarked we had found "Spillman's creek" all right, and that name it bears to this day.

Fifteen miles west we found another heavily timbered stream, which we called "Wolf creek," from the great number of wolves we killed there. Other hunters, following us later, adopted the names we had given these streams.

The next winter I was hunting far up the Smoky Hill, but found nothing, the country being burnt over, a silent, desolate waste. Crossing north to the Saline we found the same desert conditions, but from a high bluff looking north I could see in the distance timber in a gulch coming out of the divide, and the tops of the adjoining hills appeared black. We drove in that direction, arriving just at sunset, and found the hills covered with buffalo, elk and deer in the ravines, gangs of wolves trotting around, and droves of turkeys in the groves of oak, elm and cedar along the stream, which was dammed by beaver at short intervals, so that no water escaped to the plain. All together, it was the most beautiful spot I had ever seen. There was no indica-

tion that white men had ever visited the place. I told my men we had found "paradise" at last. The stream and valley became known as "Mead's Paradise"—a hunters' paradise it was. In one day we secured eighty-two wolves and as many buffalo, elk and deer as we wished. In 1860 Gen. Hugh McKee, of Leavenworth, surveyed the Saline river country and adopted, in his report, the names I had given to these streams. Near the site of our camp the town of Paradise now stands.

The "Ninnescah" river is an Osage (Dakota) name, meaning "good spring-water," from the great number of springs coming out of the Tertiary gravels of its upper course.

"Neosho" is also an Osage name, meaning "ne," water, and "osho," clear—Neosho, water clear. In the Indian languages the adjective comes after the noun.

"Smoot's creek," in Kingman county, was named after Col. S. S. Smoot, of Washington, D. C., who surveyed that county in 1865.

"Chisholm creek," which runs through the east side of Wichita, was named after Jesse Chisholm, a noted Cherokee trader, who built the first cabin on the creek, and occupied it with his family from 1864 to 1867.

"Hell creek," a branch of the Saline, was appropriately named from some experiences of myself and other hunters in buffalo days.

"Medicine Lodge" is of Indian origin. The first explorers found on that stream a great house built of posts, poles, and brush, where from time out of mind the Cheyenne Indians annually assembled to worship the Great Spirit and initiate their young men in their secret rites and ceremonies, thus preserving ancient traditions and customs. White men called this "making medicine"; hence the name, "Medicine Lodge."

"Skeleton creek" was a name we gave to a stream in Oklahoma in 1867. When the Wichita Indians, moving south, died of cholera in great numbers, on the head of that stream close to the present town of Enid, I saw their skeletons lying unburied on the ground a month or two after their death. Prior to that time the stream had no name.

"Round Pond creek," in Oklahoma, was named by us in 1864, from a circular body of water surrounding a beautiful island, which had been in former years a bend of the stream. In time the narrow neck of land was worn through, leaving a lake surrounding an island. In time the Rock Island railroad, following our trail south, crossed Pond creek near this lake, and the towns of Round Pond and Pond Creek were founded. One of these towns survives.

Washburn College Observatory.

LOSS OF TEETH AS A DISQUALIFICATION FOR MILITARY SERVICE.

By EDWARD BUMGARDNER, Lawrence, Kan.

Read before the Academy, at Topeka, December 31, 1902.

THE relation of the teeth to the general economy is nowhere better shown than in the army recruiting office. In the selection of men for military service, a fixed standard is necessary, in order to prevent the enlistment of men who would not make effective soldiers. Tripler's Manual, the recognized authority in the examination of recruits, gives "teeth white and in good condition" as a characteristic of an able-bodied man. In the time of the war of the rebellion, the examining surgeon was directed to ascertain "whether he has a sufficient number of teeth in good condition to masticate his food properly, and to tear his cartridge quickly and with ease. The cartridge is torn with the incisor, canine or bicuspid teeth." Section 20 of paragraph 85, "Revised Regulations," was more explicit, stating that men should be rejected who had suffered "total loss of all the front teeth, the eye-teeth, and first molars, even if only of one jaw." This was a very low standard, as the *total loss* of a smaller number of teeth than here indicated interferes with proper mastication. Still, the reports show that nearly three per cent. of the men examined from 1861 to 1865 failed to measure up to this standard. The following figures are taken from a report issued from the provost marshal general's bureau in 1875:

Nativity.	No. examined.	No. rejected.	Percentage.
United States, white	315,620	10,043	3.1820
United States, colored	25,828	222	.8595
United States, Indians	121	0	.....
Total, United States	341,569	10,265	3.0052
Foreign born	159,599	2,701	1.6923
Totals	501,068	12,966	2.5877

Through the courtesy of George M. Sternberg, late surgeon general of the army, I am able to present corresponding data covering the period of our recent war with Spain for comparison with the table given above. The directions to the examining officers are now as follows:

"The condition of the teeth is to be considered solely with reference to the proper mastication of food. If there are not enough in the mouth for this purpose, food is swallowed without the necessary preparation, and indigestion, with imperfect nutrition, and its consequent evils, are the result. If several of the teeth are decayed, especially about the crown, it is probable that before the ex-

piration of an enlistment they will be so far destroyed as to render mastication imperfect; hence, men who have lost the front teeth from decay and have many unsound back teeth should be rejected. The loss of the front teeth through accident is not cause for rejection, provided a sufficient number of the back teeth are sound. Unless an applicant has at least four sound double teeth, one above and one below on each side of the mouth, and so opposed as to serve the purpose of mastication, he should be rejected. Exception may be made by the adjutant general in the case of a soldier who desires to reenlist, if a report is made showing his age, physical condition as to nutrition, and the number and location of the sound teeth. If the front teeth remain and the double teeth are gone, rejection is demanded. Artificial substitutes cannot be considered as equivalent in value to the natural teeth, or as removing the disability on this account for military service."

In the years 1898, 1899 and 1900 there were 181,477 candidates for enlistment examined, and, in accordance with the instructions, 2326, or about one and one-third per cent., were rejected, as follows:

	No. examined.	No. rejected.	Percentage.
White	168,655	2,326	1.380
Colored	12,822	90	.702
Totals	181,477	2,416	1.331

At first, it would seem that the percentage of rejection was much smaller during the Spanish war than during the war of the rebellion. But the element of age has not yet been considered. The men who were examined for enlistment in the Spanish war were, as a rule, young, strong, energetic men, who desired and expected to be accepted for service. A large ratio of the men who were examined late in the rebellion were past the age that was taken as a maximum during the Spanish war. The relation of age to the percentage of rejection is indicated in this table, which gives the result of the examination of more than a third of a million men in the latter part of the rebellion:

Age.	No. examined.	No. rejected.	Percentage.
Under 20	58,952	68	.1153
20 to 25	78,639	647	.8227
25 to 30	56,711	1,114	1.9643
30 to 35	45,777	1,783	3.8950
35 to 40	50,456	2,887	5.7218
40 and over	43,786	3,801	8.6809
Totals	334,321	10,300	3.0809

Earlier in the war the ratio of rejection was lower. Of 806,610 men examined in the first years of the war, 12,904, or 1.599 per cent., were rejected; but 501,002 of these were drafted men, of whom 9646, or 1.925 per cent., were exempted.

The ratio of colored men rejected during the rebellion was about one-fourth that of white; now it is more than one-half—this notwithstanding the fact that the colored recruit of to-day is younger in proportion. To quote again from Tripler's Manual: "It has been

observed that for acceptable colored recruits the age of twenty-five or twenty-six is practically the maximum, because after that they are liable to be physically stiffened and mentally dulled." (The limit of thirty-five is the extreme for recruits under ordinary circumstances.) The negro does not seem to have been improved physically by freedom.

To sum up in a single sentence, I would say that the man of to-day does not have better teeth than the man of forty years ago; and the negro of to-day does not have as good teeth as his grandfather had in slavery.

ON CERTAIN METHODS OF THE GEOMETRY OF POSITION.*

By ARNOLD EMCH, Boulder, Colo.

Read before the Academy, by title, at Iola, December 31, 1901.

I. INTRODUCTION.

THE present tendency of scientific specialization is generally justified; it is in the interest of pure science. This is especially true of the devolopment of mathematical branches, where everything foreign to the fundamental axioms is carefully discarded. A science in which this spirit is applied intentionally and systematically becomes a branch of philosophy; for instance, Grassmann's Linende Ansdehnmgslehre, Lobatschesky's Geometry, v. Standt's Geometrie der Lage, Weierstrasse's Theory of Functions, etc. As such they are of the greatest importance for the rigorous development of mathematical thought, and their value cannot be overestimated. It is a question, however, whether so-called pure methods are always what they pretend to be, and whether they are always to be recommended for pedagogical purposes. To take an example: Is it well to consider certain configurations in space in order to simplify the demonstration of propositions in plane geometry; or is it necessary, in order to be consistent, to apply only previously known propositions of plane geometry?

There is no doubt in my mind that the first can be done in a successful and consistent manner. In this paper I shall attempt to show the value of such methods for the teaching of the geometry of position. At this point I desire to say that descriptive geometry, as well as projective geometry, or the geometry of position, ought to be made regular courses in the mathematical departments of real universities. A knowledge of elementary descriptive geometry gives the student an invaluable power for the mastery of the more difficult problems of projective geometry and of higher geometry in general.† In what follows I shall assume the knowledge of ordinary descriptive geometry.

II. ADVANCED PLANE GEOMETRY.

There are a great number of propositions in plane geometry which appear in their natural light when considered as projections of figures in space. As such they are independent of metrical relations and it is unnatural to prove them by equations. As an example, I may mention the homology of triangles.

---

*A paper read before the American Association for the Advancement of Science, at Denver, Colo., August, 1901.

†Regular courses in descriptive and projective geometry are now offered at nearly all universities of continental Europe.

Two triangles, A B C and A′B′C′, are homologous,

1. When the rays AA′, BB′, CC′, joining corresponding points, are concurrent; or, also,

2. When the points of intersection of corresponding sides A B and A′B′, BC and B′C′, CA and C′A′ are collinear.

Each of these two definitions as a hypothesis necessitates the other as a thesis.

Casey, in his Sequel to Euclid, which is very rich in beautiful examples and propositions, but without an organism, reduces advanced geometry to an incoherent mass of metrical facts. To prove the propositions concerning homologous triangles, he introduces ratios of areas of triangles, and applies the theorem of Menelaos concerning transversals.* The same method is followed in most treatises on plane geometry. The immortal elements of Euclid, which in themselves are of rare beauty and rigor, lead very soon to sterility when applied to projective properties of figures.

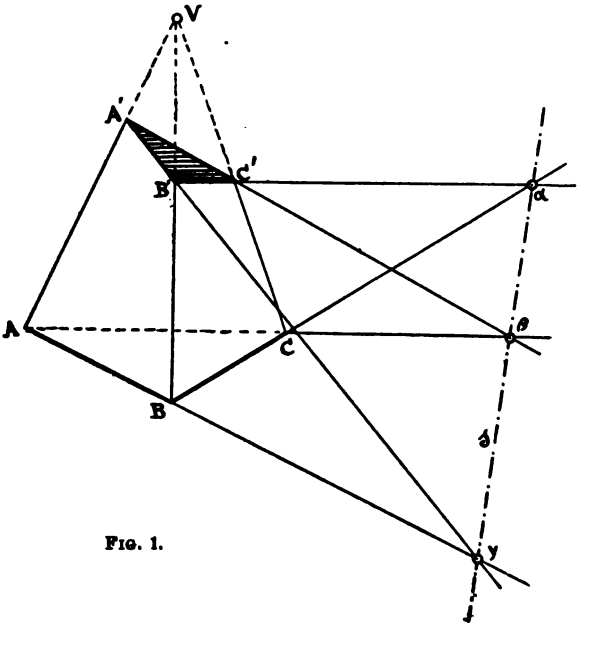


FIG. 1.

Homologous triangles appear in the simplest manner as plane sections of triangular pyramids. Let V be the vertex of such a pyramid and ABC and A′B′C′ the intersections of its edges, with two oblique planes, P and P′, respectively. Let S be the line of intersection of P and P′. A glance at the figure (fig. 1) shows that AB and A′B′, BC and B′C′, CA and C′A′ meet in points of S.

* Loc. cit., book sixth.

Now, two triangles, ABC and A'B'C', in which AA', BB', CC' produced are concurrent may always be considered as the projection of a triangular pyramid cut by two oblique planes in ABC and A'B'C'. Thus the foregoing proposition is established. In a similar manner the converse proposition may be proved.

As a second example, let us take the proposition concerning three circles in a plane:

The external centers of similitude of three circles of a plane are collinear. Any two internal centers of similitude are always collinear with one of the external centers.

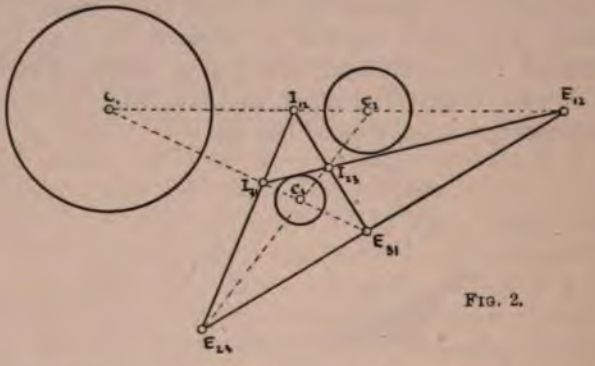


FIG. 2.

To prove this, let us consider three spheres whose projections are the three given circles in the plane. Any two of these spheres admit of an internal and external common tangent cone. Thus, designating the centers of the spheres by C_1, C_2, C_3, we obtain three external and three internal tangent cones whose respective vertices E_{12}, E_{23}, E_{31}, and I_{12}, I_{23}, I_{31}, are coplanar, the plane P passing through C_1, C_2, C_3. The three spheres and the six cones have the same common tangent planes and these are 2 by 2 symmetrical with respect to P. Any two symmetrical planes (there are eight common tangent planes) are common tangent planes to the three spheres and to three of the tangent cones.

The three vertices of these cones are therefore necessarily collinear. We have therefore the result that the six vertices of the common tangent cones are coplanar and are 3 by 3 situated in straight lines; *i. e.*, they form a complete quadrilateral.

The collinear groups are, fig. 2:

E_{12}	E_{12}	E_{23}	E_{31}
E_{23}	I_{23}	I_{31}	I_{12}
E_{31}	I_{31}	I_{12}	I_{23}

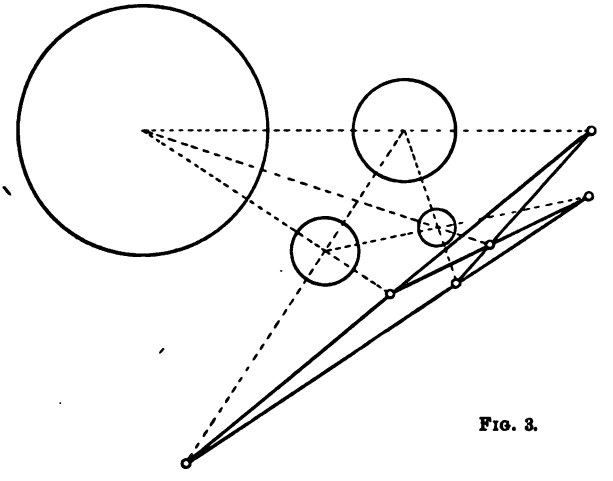


FIG. 3.

Any orthographic or central projection of this configuration leads immediately to the original proposition. We may conversely use relations in a plane to establish propositions in space. Take, for instance, four circles in a plane and construct their external centers of similitude (fig. 3). It is found that they form a complete quadrilateral, whose six points are 3 by 3 collinear. The four circles may be considered as projections of spheres in space. Here the collinearity of the vertices of corresponding common tangent cones still exists, and we have therefore the theorem:

The six external centers of similitude of any four spheres in space are coplanar.

Similar propositions hold for the internal centers.

III. ORTHOGRAPHIC PROJECTION.

In most text-books on descriptive geometry no attention is paid to certain geometrical principles which, as it will appear, form the base for nearly all projective constructions. It is also remarkable how easy these principles and relative propositions may be derived from exact intuition in space. From this point of view the necessity of including certain geometrical propositions in a course on descriptive geometry is imperative. I shall illustrate the points in question by the treatment of affinity of figures* (homology with an infinite center).

* Fiedler: Geometrie der Lage, vol. 1, pp. 1-115.

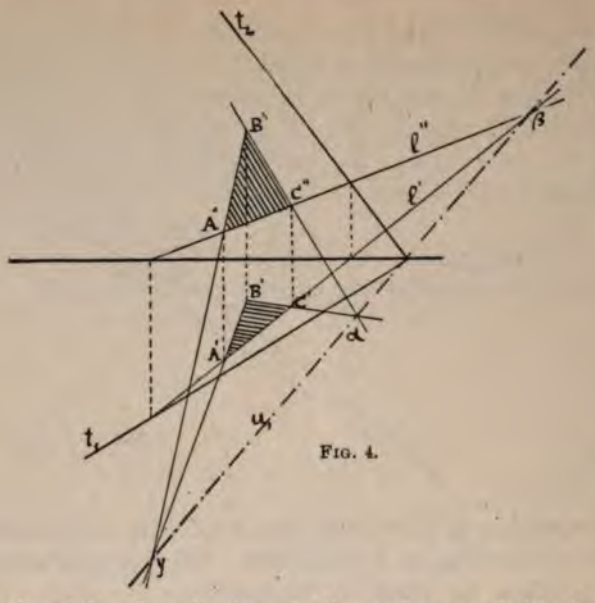


FIG. 4.

The horizontal and vertical projections of any point in the bisecting plane of the second and fourth angle coincide. From this it follows that the projections of the piercing point of any line with the bisecting plane, which shall be designated by U, coincide, and are consequently obtained as the point of intersection of the two projections of the straight line. Let l' and l'' be the projections of a line l and D_1 their point of intersection. In a similar manner, we designate by A_1, B_1, C_1,....; a_1, b_1, c_1,....the coinciding projections of points A, B, C, ...and lines a, b, c,.... in U. As two points determine a straight line and as the projections of a point in U coincide, it follows that the projections of any line in U coincide also. Any plane P with the traces t_1 and t_2 intersects U in a line u, whose projections coincide in u_1. Evidently the traces t_1, t_2 and the lines u and u_1 meet in the same point T of the ground line. The line u is therefore determined if another point is known. To find such a point, assume any straight line l in the plane P, figure 4, and construct its intersection L with U. The straight line connecting T with L, or in the projections T with L_1, is the required line. Every line in the plane P intersects the line u; hence its projections meet in a point of the line u_1. From this it is seen that the projections of points, lines and figures in a plane P are related by the two laws:

1. Corresponding projections of lines meet in points of a fixed straight line (axis of affinity).

2. Corresponding projections of points are situated in parallel lines.

These are precisely the laws dominating the affinity of figures in a plane, which itself is a special case of homology (when the center is infinitely distant). The propositions which we have established in connection with homologous triangles may be specialized for triangles related by affinity and their proof does not present the slightest difficulty. In fact, affinity results from homology by considering a triangular prism instead of a triangular pyramid, and it is clear that our previous reasoning applies also to this case.

I shall now mention two metrical specializations of affinity. Assume two triangles ABC and A'B'C' related by affinity and assume that the parallel lines AA', BB', CC' be perpendicular to the axis of affinity, then the ratios between the distances of corresponding points from the axis of affinity are equal and the proposition holds:

The areas of the two triangles are to each other as the distances of corresponding points from the axis of affinity.

If this ratio is unity then their areas are equal and the triangles are in axial symmetry.

If AA', BB', CC' are parallel to the axis of affinity then the areas of ABC and A'B'C' are equal.

This is a case which is never considered in plane geometry.

I might extend this subject still further, but I hope the previous treatment will be sufficient to show in what a simple and effective manner, and without losing much time, important geometrical propositions may be obtained from the study of elementary descriptive geometry. It is hardly necessary to point out that these propositions are conversely the most efficient and rapid means to make projections of plane figures.

Suppose, for instance, that the horizontal projection of a plane figure A, B, C, ..., the vertical projection C'' of C and the line of intersection u of the plane of ABC... with U be given. The vertical projection A''B''C''... may be constructed by the previous principles alone. Thus, to find B'', connect B'C' and prolong to the intersection with u_1; join the latter point to C'', and from B' draw a perpendicular to the ground line. Where this perpendicular intersects the last line, is the required vertical projection B'' of B. By this method three lines are sufficient to find a required point, while the ordinary method by means of the traces of the plane requires four or five (two parallels and two perpendiculars in one case, and two connecting lines and three perpendiculars in the other). The same principle may be applied to find the true shape of a plane figure from its projections; three lines give a point of the rabatted figure. This method is, therefore, also in the line of Lemoin's Géométrographie,* where fig-

*M. E. Lemoin: Principes de la Geometrographie, Archiv der Mathematik und Physik, vol. 1, 1901, p. 99.

ures are constructed and investigated with reference to the greatest attainable simplicity. I can say from experience that there is hardly a subject in descriptive and advanced plane geometry in which the student takes more real interest than in this method of presenting the construction of plane figures in descriptive geometry, and of introducing propositions of projective geometry. It seems to me the most natural way to higher geometry.

IV. COLLINEATION.

As in the previous chapter, I shall start from elementary constructions in descriptive geometry and through the study of perspective gradually arrive at the most general expression of collineation.

A central projection, or a perspective, is determined by the plane of projection (pictorial plane) and the center (eye). Assuming the plane of the paper as the plane of projection and any point in space as the center, it is possible to construct the perspective of any figure in space in this plane. The center can be most easily located by a circle in the plane of projection. The radius of this circle is the distance of the center from the plane and the center of the circle is the orthographic projection of the center of projection upon the plane of projection. This circle has been introduced into geometry by Professor Fiedler, of Zurich, and he calls it distance circle (distanzkreis).*

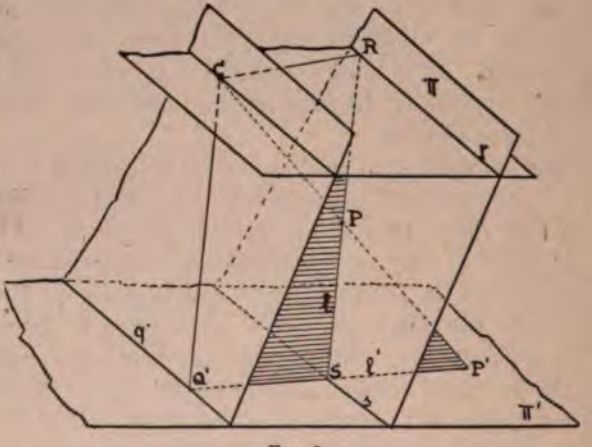


FIG. 5.

Let II′ be the plane of projection and II an arbitrary plane, whose projection upon II′ shall be made from a center C. Let S be the line of intersection of II′ and II, fig. 5. To obtain the projection of any point P′ of any point P in II, connect P with the center C; then the point of intersection of this connecting line (indefinitely produced)

*Darstellende Geometrie, vol. I, 1883. It must be mentioned that Courinery already uses a "cercle a distance" in his Geometrie Perspective, Paris, 1828.

with II′ is the required point P′. In a similar manner the projection l′ of a line l in II is obtained as the line of intersection of the plane passing through C and l with II′. From this construction the following fundamental laws are immediately clear, and are in fact a mere restatement of the laws of homologous triangles previously considered.

To every point of II corresponds one and only one point of II′, and conversely, and both points are on the same ray through C.

To every straight line of II corresponds a straight line of II′, and conversely; and both lines meet at the same point of s (holds for any line).

To the infinite line q of II corresponds a line q′ of II′, which is parallel to s. Conversely, to the infinite line r′ of II′ corresponds a line r parallel to s.

The plane II is usually determined by its trace s in II′ and either of the lines r and q′. If a straight line l in II is given, intersecting the trace s in S′, the corresponding line l′ is obtained by drawing a line through C parallel to l and marking its point of intersection Q′ with q′. It is evident that Q′ is the projection of the infinitive point of l, and the projection of l consequently passes through S′ and Q′. Another way is to produce l till it intersects r in R and to join C with R. The line through S parallel to CR is the required projection l′ of l. From the figure, it is seen that CRSQ′ is a parallelogram and that PS : PR = P′S : CR.

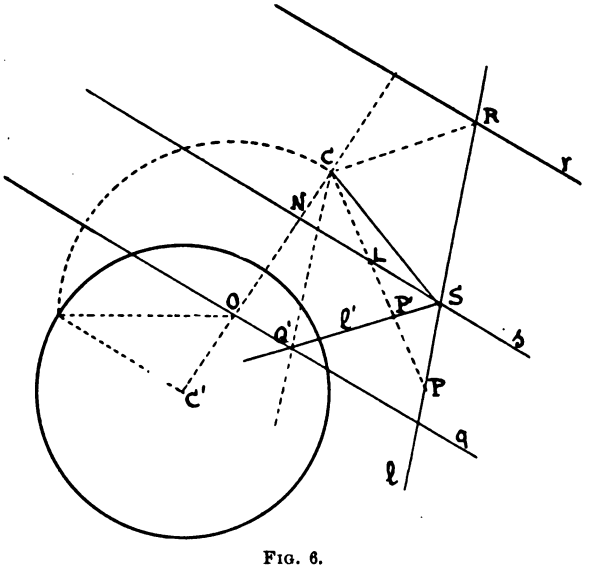


FIG. 6.

The planes through C parallel to II and II′ form a space of a parallelepipedon. Keeping II′ fixed it is possible by rotations about s and

q′ as axes to rabatte the planes through C, and II into II′ without changing the figures situated in these planes. After the motion there is still CR = and ‖ Q′S and SP′ = SP′, so that the distances PR and PS remain also unchanged. From this it follows that after the motion P′ and the rabatted position of P lie on a ray through the revolved position of C. The laws expressing the relations between the revolved and projected figure are therefore the same as those between the figure in space (II) and its projection II′. After the rabattement, fig. 5 assumes the form of fig. 6. Here l and l′ are the two corresponding lines which with s and SC form a pencil of four rays through S. As CP and CQ intersect this pencil there is

$$(CLP'P) = (CMQ'Q).$$

The value of (CMQ′Q) is $\frac{CQ'}{MQ'} = \frac{CO}{NO} = k$, ray; *i. e.*, entirely independent of the position of l, l′, and CP. Thus, drawing any ray through C and intersecting s in S′, any two points P and P′ on this ray of the central projection form a constant ratio with C and S′. For all possible pairs P and P′ of corresponding points

$$(CSPP') = \text{constant}.$$

The different cases of central projection may be classified according to the position of the center of projection and the value of the constant k.*

Laying any Carterian system of coordinates through C, and designating the coordinates of any pair of corresponding points P and P′ by x, y, and x′, y′, respectively, it is an easy matter to derive from the figure the general form of the relation existing between these coordinates:

$$\left.\begin{aligned} x' &= \frac{ax}{dx+ey+f}, \\ y' &= \frac{ay}{dx+ey+f}, \end{aligned}\right\} \qquad (1)$$

where $\frac{f}{a}$ is the constant k of the projection.

Formulas (1) represent the transformation of a point P into P′, called perspective.

The equation of the line r is $dx + ey + f = o$, and its corresponding line r′ is infinitely distant. To the line q ($x = \infty$, $y = \infty$) corresponds the line q′ with the equation $dx' + ey' - a = o$. The axis s is obtained by putting $x' = x$, $y' = y$, and its equation is $dx + ey + f - a = o$. Comparing the equations of the lines r, s, q′, and their distances from C, it is found that

$$\frac{f-a}{\sqrt{d^2+e^2}} = \frac{f}{\sqrt{d^2+e^2}} - \frac{a}{\sqrt{d^2+e^2}},$$

*Fiedler, loc. cit., p. 95.

as it also appears from the figure. The deduction of formulas (1) from an actual perspective construction has the great advantage that all results gained from the analytical discussion may easily be interpreted constructively and geometrically. It is noticed that a perspective transformation depends upon three essential constants, *i. e.*, if its center is fixed. This is equivalent to saying that the axis of perspective can be chosen in a doubly infinite number of ways, and the constant k in a singly infinite number. If to the perspective transformation P, as given by (1), we apply a dilation D, defined by

$$x'' = dx',\ y'' = y', \tag{2}$$

and which may be considered as a special case of perspective where the center is infinite in a direction perpendicular to s. From this it is seen that the combination of a perspective and dilation (PD) may be expressed by

$$\left.\begin{aligned} x'' &= \frac{ax'}{dx' + ey' + f}, \\ y'' &= \frac{by}{dx' + ey' + f}. \end{aligned}\right\} \tag{3}$$

Applying to this transformation consecutively a transformation by equal areas (A), defined by

$$\left.\begin{aligned} x''' &= x'' + ky'' \\ y''' &= y'' \end{aligned}\right\}, \tag{4}$$

and which may also be considered as a special case of perspective, in which C is infinitely distant in a plane perpendicular to the bisecting plane of II and II′; then a transformation (T), defined by

$$\left.\begin{aligned} x^{(4)} &= x''' + p \\ y^{(4)} &= y''' + q \end{aligned}\right\}, \tag{5}$$

and finally a rotation (R),

$$\left.\begin{aligned} x^{(5)} &= nx^{(4)} - my^{(4)} \\ y^{(5)} &= nx^{(4)} + my^{(4)} \end{aligned}\right\}, \tag{6}$$
$$(m^2 + n^2 = 1),$$

we arrive at a transformation of the form

$$\left.\begin{aligned} x' &= \frac{ax + by + c}{dx + ey + f}, \\ y' &= \frac{gx + hy + j}{dx + ey + f}. \end{aligned}\right\} \tag{7}$$

This transformation is characterized by eight independent constants, and is called, as is well known, a projective transformation, or collineation. It may be considered as the result of the combined transformations

$$(P\ D\ A\ T\ R), \tag{8}$$

which are determined by 3, 1, 1, 2 respectively. It is

also well known that the latter are subgroups of the general projective group. From the constructive study of collineation we have thus arrived at the conception of the continuous projective groups of transformation. The method which we have followed makes it again possible to follow the train of reasoning in the discussion of groups by illustrative constructions. It may, of course, be extended to space.

V. CONCLUSION.

A well-arranged parallelism of descriptive, synthetic and analytic methods in organic connection, a method chiefly cultivated by Fiedler, seems to be most valuable for a rapid introduction into the fields of higher geometry. The introduction of critical discussion concerning the foundations of geometry into elementary treatises has a tendency to confuse the student. The establishment of the fundamental principles of projective geometry independent of metrical relations or of the eleventh axiom of Euclid may follow an introduction as outlined in this paper. v. Standt's construction, Fiedler's projective coordinates, Caley's and Klein's absolute geometry, or non-Euclidian geometry, must form indispensable parts of such an advanced study. In the method followed by us, and which is partly, also, that of Poncelet, Steiner, and Charles, the projective properties of the circle are easily established and transferred to conics by perspective. It is, however, necessary to show that all curves of the second order defined as products of projective ranges and pencils, or analytically by equations of the second degree, are conics. There is no difficulty in doing this.

Descriptive analytic methods are also of invaluable service for the study of congruences and complexes of rays and for higher geometry in general. In this respect I may mention the treatment of linear complexes, the congruence of bisecants of a twisted cubic, of the "Null system," by descriptive methods, and their elegant representation by certain partial differential equations.*

There is one branch of mathematics which is rarely mentioned in connection with projective geometry, namely, kinematics. In the hands of Penucellier, Kempe, Sylvester, Hart, and, in recent times, especially by Professor Koenigs, of Paris, kinematics has rendered valuable services to modern geometry. Starting from the beautiful theorem † that every plane and twisted algebraic curve and every algebraic surface may be described by a linkage, Koenigs invented a planigraph, and quite recently, also, a link-motion perspectivograph, realizing collineation. A short treatment of these interesting linkages would form a valuable addition to any text-book on projective geometry.

---

*See my paper "On the Congruences of Rays (3, 1) and (1, 3)," Annals of Mathematics; also, S. Lie: Geometrie der Beruhrungs-transformationen, vol. I, p. 326.

†Koenigs: Lecons de Cinematique, Paris, 1897, pp. 271, 297, 305.

THE ELEVEN-AND-ONE-HALF-INCH EQUATORIAL TELESCOPE,

WASHBURN COLLEGE OBSERVATORY.

By H. L. Woods, Washburn College, Topeka.

Read before the Academy, at Topeka, January 1, 1903.

THE telescope lately erected in the new observatory of Washburn College is of very moderate size when compared with the many large instruments. However, it is hoped that a short description of it may be not entirely without interest. The objective has a clear aperture of 11½ inches and a focal length of 165 inches. The form of the lens is of the Herschel pattern, with no air space except that due to variation in the curvature of the surfaces. The glass was furnished by Mantois, of Paris, who also furnished the glass for the Lick and the Yerkes objectives. The lens was ground by Brashear, of Allegheny, Pa. There are five eyepieces, of the following powers: 120, 165, 220, 330, and 715. A helioscopic eyepiece is provided, and a wide-angle comet eyepiece of 150 power. The finder has an aperture of three inches and a power of twenty.

The column to the top of the declination head is ten feet in height. It is made in three sections, including the declination head. On the inside of the base, near the bottom, are cast lugs to support a floor of wood and concrete, which effectually prevents air currents from passing through the column. This has been found to be a protection to the clock in frosty weather, where, as is the case with this instrument, there is an open air space below the base. The second section contains the driving clock, and carries on its north side the R. A. dial and reading microscopes for the fine hour circle. The two sections of the column proper and the declination head are rigidly bolted together. Their aggregate weight is 2350 pounds.

The thrust at the lower end of the polar axis is taken by ball bearings in phosphor-bronze casings. The upper end of the axis is carried by a phosphor-bronze bearing. The friction at this point is relieved by anti-friction rollers. The polar axis terminates in a head to which is attached by heavy screws the declination sleeve. Through this sleeve runs the declination axis, which in turn contains the rods for operating from the eye end of the telescope tube the clamp and slow motion on the polar axis.

The tube is of steel sheets closely riveted. The main draw-tube for focusing is operated by rack and pinion and carries a smaller draw-tube. Both tubes are provided with scales for locating proper posi-

tions for different uses of the instrument. Two weights sliding on rods which are attached by brackets to the eye end of the tube counterpoise the objective. The entire tube is counterpoised by five cylindrical weights which are threaded onto the opposite end of the declination axis. This system of counterpoises admits of very prompt and accurate balancing of the tube, called for by the addition or removal of accessories such as micrometer, spectroscope, or photographic attachments.

The system of circles for setting and for determining positions is very complete and convenient. The coarse hour circle near the lower end of the polar axis is divided to five minutes of time. Its graduations are easily visible from the floor. Setting in right ascension is, however, much more advantageously effected by a dial set into the north side of the column. The graduations on this dial read by a vernier to single minutes of time. The hand wheel for shifting the telescope rapidly in right ascension is situated just below the dial. The coarse declination circle is graduated to degrees and easily read from the floor or observing chair. The fine hour circle reads to five seconds of time, and is read by means of prisms through microscopes which project from the north side of the pier just above the R. A. dial. This arrangement permits the observer to read the fine hour circle and the setting dial and to operate the rapid motion without changing his position. The fine circle in declination reads by verniers to thirty seconds of arc and is read by microscopes at the eye end of the telescope.

All the circles and the R. A. dial are lighted by small incandescent lamps. The current is distributed and controlled in the following manner: The mains are brought up through the column to a switch just below the R. A. dial. This switch lights, as desired, the R. A. dial, the hour circle, or the coarse declination circle. The current for the hour and declination circles and the micrometer is carried through contact rings on the polar and declination axes. A switch at the eye end lights the fine declination circle or the micrometer. The lights are all carefully shaded, and may be left turned on, if desired, without interfering with observations.

The driving clock runs very smoothly and quietly. It is provided with a maintaining device which permits winding without disturbing the motion of the telescope. All the bearings of the clock, the connecting gears and the axes are exceedingly well fitted. This is attested by the fact that when the instrument was being set up, and before it was perfectly balanced and adjusted, the driving clock, with but seventy pounds of weights—one-half the full amount provided—maintained the motion of the telescope at nearly its required speed at

The New Equatorial Telescope in the Washburn College Observatory.

the very first trial. The weight of the movable parts of the telescope is about 1000 pounds.

The column and the tube are enameled in a dark green. Comparatively little brass is used in the construction. What is exposed is finely lacquered. In design, construction and finish the entire instrument is a fine specimen of mechanical skill. It received the grand prize at Paris in 1900, and the highest award at the Pan-American.

A few words concerning the support and housing of the instrument may be of interest. The base rests on two fifteen-inch I beams running north and south. Underneath these are two others of the same size running east and west. The observing floor, which is fixed, is eleven inches above the top of the upper beams.

The dome room is 21 feet 6½ inches in diameter. It is covered by a 26-foot copper-sheathed dome. The observing slit is 40 inches wide in the clear and is closed by a single shutter. The height from the observing floor to the center of the dome is 26 feet 9 inches.

The dome weighs about fifteen tons, and is carried on a steel track by twelve conical rollers with roller bearings. It is rotated by an endless wire cable passing over a sheave which is operated by a hand rope and pulley. A light pull with one hand is all that is required to shift the position of the dome.

Both telescope and dome were built by the Warner & Swasey Company, Cleveland, Ohio. The erection was under the charge of their representative, Mr. E. P. Burrell, whose skill and care in the work deserve special mention.

REVIEW OF THE CROP SEASON OF 1902.

By T. B. Jennings, Topeka.

Read (by title) before the Academy, at Topeka, January 2, 1903.

JANUARY.

THE mean temperature was 1.3 degrees above normal and the precipitation averaged 0.09 above the normal. The first three weeks of the month were unusually warm and dry, followed by colder weather, and much snow the last ten days. Much plowing was accomplished in the southern counties. Wheat, not pastured too closely, continued in good condition, and during the cold weather was covered with snow two to six inches deep.

FEBRUARY.

Was cold and dry, the mean temperature being 3.2 degrees below normal and the precipitation 0.27 of an inch below. During the coldest part of the month the wheat in the eastern and many of the central counties was fairly well covered with snow. At the close of the month the wheat was generally in good condition, though in some of the central counties it had been somewhat damaged by the cold. Plowing was resumed in the southern and some of the central counties during the last week, and oat sowing began in Montgomery county and barley sowing in Clark.

MARCH.

Wheat improved rapidly in the last ten days of the month, and, with few exceptions, was in fair condition in the central counties, and fine condition in the eastern, being in the best condition where the snow had remained the longest in the winter. Oat sowing was well along in the northern counties; completed in the southern, where they were coming up. Corn planting had begun in the south. Early potatoes were mostly planted. Flax sowing had begun south. Tame grasses were growing well in the south and starting in the north, with prairie grass starting in the south and alfalfa greening. Peach and apricot trees were beginning to bloom in the south; but the peach buds had been winter-killed in the north and mostly killed in the central counties.

APRIL.

The weather was not favorable for crop growth, but fine for field-work, except on the 20th, 21st, 22d, and 25th, when high winds were general. Wheat continued in good condition in the central and southern counties of the eastern division, where the principal rains

occurred during the month, but in the northern and central counties of the state it was more or less injured by the dry weather and high winds. Corn planting was pushed during the month, and by the end of the month the early planting was generally up in the central and southern counties, and was being cultivated in the south. Oats were generally up the first part of the month, but the prevailing weather was not conducive to rapid growth. Flax sowing was nearly completed by the middle of the month and the flax was coming up. Grass started slowly. Peaches bloomed well in the southern and most of the central counties, but many had been winter-killed in the northern. Apples, cherries and plums were blossoming by the close of the month.

MAY.

A good month for the growth of crops. Wheat began heading in the southern and central counties, and corn cultivation became general in the same district the first week. Oats, grass and alfalfa improved rapidly. Early strawberries were marketed in the south. Canker-worms were damaging some orchards. Warm weather and favorable rains continued through the second week; wheat had headed in the central counties and was blooming in some of the southern; corn was clean, a good stand, and growing rapidly; grass grew finely; oats were doing well; potatoes were in bloom south and beginning to bloom in the central counties; alfalfa was being cut in the south and was ready to cut in many of the central counties. Fine growing weather continued through the third week; wheat still improving, but it was heading short in Atchison; it was in bloom in many of the central counties and filling well in the southern; corn a good stand and growing rapidly, but ground too wet for cultivation; alfalfa cutting progressed under difficulties, and in some localities the hay was ruined by wet weather; strawberries ripened in the central counties; grass was in fine condition. The fourth week was cool and wet; although too cool for corn it was suitable for small grains and grass; wheat ripened in southern and a few central counties; corn showed need of sunshine; alfalfa cutting progressed in a few counties, but farmers generally waited for more suitable weather; some clover was cut in Woodson.

JUNE.

A fine month for growing crops. The first week of the month was warm, with light showers in the western and eastern divisions and some heavy rains in the central counties of the middle division, and much needed work was accomplished in the fields. Corn grew rapidly and began tasseling in the southern counties. Wheat harvest progressed in the southern counties wherever the ground was dry enough,

and began in the central. Oats were greatly improved this week and began to give promise of a good crop. Flax much improved. Apples improved generally, though in a few counties they fell badly. The first crop of alfalfa was generally cut, but considerable difficulty was experienced in curing and saving it. Haying began in some of the eastern counties. While the second week was warm, it was also a wet week over a large part of the state, and not only interfered with wheat harvest but also washed out much corn. Corn continued its fine growth. Oats improved very much; the crop began heading in the central counties and ripening in the southern. Grass growing finely. Early potatoes were fine and were being marketed in many counties. Late cherries ripened in a few southern counties. The third week was cool and wet, the temperature averaging nine degrees below normal; the wet weather retarded the wheat harvest. The oat harvest began in the south wherever possible to work. Corn grew very rapidly; it continued tasseling in the southern and some central counties, and began to silk in some southern counties. The second crop of alfalfa was fine, and in several eastern counties was ready to cut. Flax bloomed. Apples continued dropping in a few counties, and did well in others; early apples were marketed in the south. Prairie-grass continued to improve, giving promise of a fine hay crop. The fourth week was very cool for the season, the temperature ranging from ten degrees below normal, in the eastern, to six degrees below in the western counties. Little or no rain fell, except in a strip of counties extending from Finney and Reno to Republic, Marshall, and Brown. Wheat harvest progressed rapidly, and by the close of the week most of the wheat was in shock, and some stacking and thrashing had been done. Oats ripened rapidly, and harvest progressed in the southern and central counties—a fine crop. Corn was laid by in several counties; tasseling became more general; the crop gave fine promise. Flax ripening. The second crop of alfalfa was cut in many counties. Prairie-grass continued in fine condition, and new hay appeared on the market in several counties.

JULY.

Fine growing weather prevailed over the state the greater part of the month. The temperatures were seasonable the first week, with good rain over the entire state. Wheat harvest was finished over a large portion of the state, and thrashing and stacking began. Corn grew rapidly and was in fine condition; much of it tasseled and silked as far north as the Kaw, with roasting ears in the extreme south. Oat harvest progressed in many counties, and was nearly completed in the south. Flax looked fine. Apples gave good promise, the early apples being ripe and very good. Tame-hay cutting progressed this week.

The second crop of alfalfa was cut in a few counties. Potatoes were fine, with promise of an unusually large crop.

During the second week good rains fell over the larger part of the state, with the temperature slightly below normal. Wheat harvest was finished this week; much sprouting in stack began, due to the rainy, damp weather. Thrashing progressed where dry enough, with poor to good yields. Oats were generally in the shock, except in the northern counties, where they were too dry to cut. Corn continued in fine condition and growing rapidly, and yielding roasting ears in the central counties. Cutting of the second crop of alfalfa progressed slowly on account of the wet weather. Potatoes were injured some by the heavy rains and high water in the northern counties. Tame haying continued in many counties, and plowing for fall wheat began in a few.

The third week was much drier and quite warm, favorable for outdoor work, much of which was accomplished. Corn continued in fine condition in the eastern and middle divisions, but was somewhat damaged by the heat in the central and northern counties of the western the early part of the week; greatly benefited, however, by the cool weather the latter part. Thrashing from the shock and stacking of wheat and oats progressed rapidly, the oats giving very good yields. Apples were quite promising in many counties. The second crop of alfalfa was cut in many counties. Potatoes continued to give large yields in some of the eastern counties. Grass was an unusually heavy crop. Flax cutting began in a few counties.

The fourth week was warm, though the temperatures were slightly below normal, with a better distribution of rain. The corn, with a few northwestern exceptions, was in unusually good condition this week, much of the early corn in the central and southern counties being hard enough to feed. Flax cutting became more general. Tame hay was mostly secured this week, and prairie haying became more general; a fine crop. The third crop of alfalfa grew rapidly, under favorable conditions. Apples continued giving good promise in many counties, though dropping in a few. Forage crops were in fine condition. Plowing for fall sowing progressed in a few counties.

AUGUST.

Very warm weather the early part of the first week, followed by heavy showers in the northwestern, central and southern counties, lighter elsewhere, and cooler; the high temperature first of the week was unfavorable to the corn, ripening it too rapidly, but the cooler weather following not only improved the corn, but all other crops, too. Early corn was hard enough to feed in the central counties and was marketed in a few southern. Thrashing continued, with good

yields of oats and poor to good yields of wheat and flax. The third crop of alfalfa was cut in some counties and was growing well in others; a good crop. Plowing for fall seeding progressed in some counties, but was stopped in some by too much rain and in some others by hard ground.

The second week began cool, but soon changed to hot; good rains fell in the eastern half of the state, with fair rains in many counties of the western half. The early corn was practically matured this week, and cutting began in several of the central and southern counties; late corn was damaged some by the dry, hot weather of the central and western counties. Prairie haying progressed rapidly, and a fine crop was being put up. Thrashing continued and new wheat was freely marketed. Apples a fine crop in some counties, poor in others; forage crops were in good condition. A fine crop of millet hay was put up in the central northern counties.

The first part of the third week was quite warm, cool the latter part. Fine rains fell over the entire state, except the extreme southwestern counties and the north portion of the central northern counties, greatly improving the late corn, but injuring wheat, oats and flax in the shock, and stopping thrashing and plowing. Pastures, alfalfa, range grass, forage crops and apples were greatly improved by the rains and cooler weather.

The fourth week was much cooler than the third, with heavy rains over the northern and eastern counties, good rains through the central and lighter showers in the southern counties. Corn, with few exceptions, was doing well, the cool, wet weather being decidedly beneficial to the late corn, which was green and growing; cutting early corn continued; new corn was being fed in some counties. Apples were improved. The wet weather caused much wheat in stack to sprout, and retarded haying, both alfalfa and prairie; it improved forage crops and pastures, but ruined many potatoes in the ground.

SEPTEMBER.

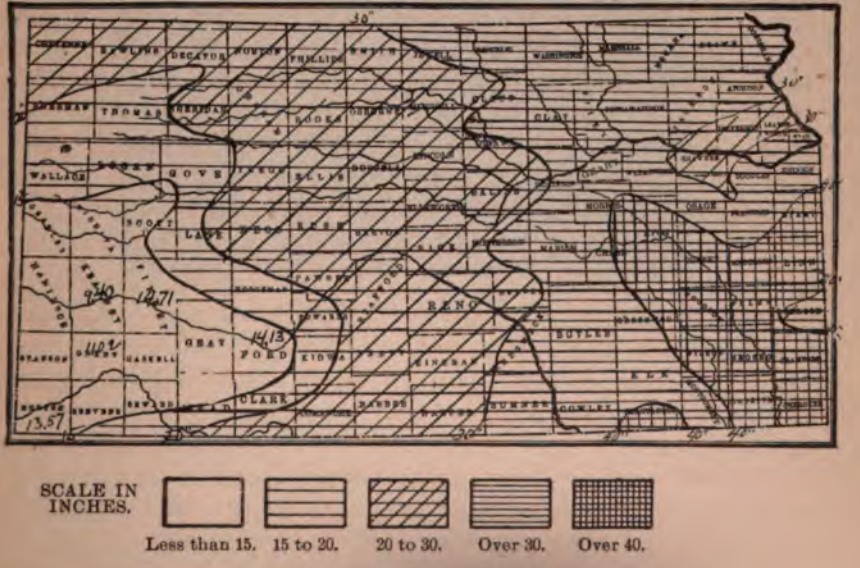
The month was cool; the first week was very wet in the eastern division; with little or no rain in the middle and western divisions; the second and third weeks were dry, except in the extreme southeastern counties; the last week was very wet, except in the extreme southwestern counties. Wheat and rye sowing began the first week and had become general by the third week. Corn cutting continued in the central and northern counties, and husking in the central and southern. Prairie haying was pushed in all parts, and a large crop was put up. Plowing progressed. Much alfalfa seed was sown, but all field-work was stopped by the heavy rains of the fourth week. Early-sown wheat and rye began coming up the second week, and by

the end of the month a good stand was had over a large part of the state. Apples were fine and the crop large; picking began the last of the month. Potato digging began the latter part of the month. Some damage was done to corn in the shock by the heavy rains the last week, which also damaged some potatoes in the ground.

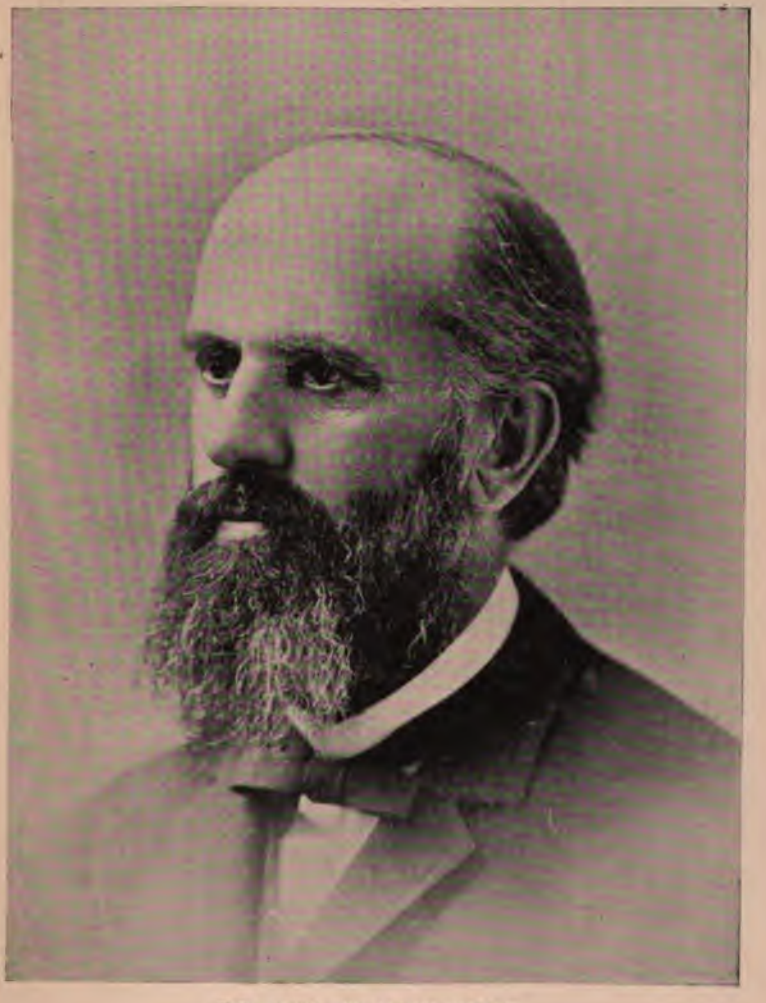
OCTOBER.

In the eastern division, the weather was quite favorable for farm work after the first week; owing to previous wet-weather delays in sowing, much wheat was sown after the 10th; early-sown wheat was up, growing well, and presented a good stand. Corn husking was being pushed; the crop was good in quality and quantity. The Pottawatomie sweet potatoes have all been secured. Fall seeding of alfalfa and English blue-grass was successful in the north. In the middle division, wheat was growing fairly well; at the close of the month, wheat sowing was progressing in several counties, and finished in some, but was stopped by the dry ground in some of the southern counties. Corn husking was progressing, though in Phillips corn was rather green yet. The second growth of hay was in the head in Sumner, and some was being cut for hay. In the western division, growing wheat was in fine condition, but much remained to be sown, the ground having been too wet the first part of the month. Weather quite favorable.

RAINFALL FOR CROP SEASON OF 1902.



COL. N. S. GOSS.



DR. GEO. T. FAIRCHILD.

VI.

NECROLOGY.

Col. N. S. Goss,

Dr. Geo. T. Fairchild,

Davis A. Boyles.

COL. N. S. GOSS.

NATHANIEL STICKNEY GOSS was born in Lancaster, N. H., June 8, 1826. At an early age he moved with his father to Pewaukee, Wis. Here he received a common-school education, supplemented by a few short terms in a local academy. In 1857 he came to Kansas and became one of the first settlers at Neosho Falls. In 1860 he was elected major in the Sixteenth Kansas Cavalry, and in 1863 he was made lieutenant-colonel. He was employed for a time as a scout for United States troops. He served as register of the United States land-office at Humboldt, and was for a time land attorney for the Missouri, Kansas & Texas railway, and also for the Atchison, Topeka & Santa Fe. He was president of the Neosho Valley railroad during its construction.

Colonel Goss was, from his youth, a lover of birds. He always devoted such leisure as he could find to their study, and, when he retired from active business, devoted the greater part of his time to collecting and preparing the magnificent ornithological exhibit which he afterward presented to the state of Kansas. It is one of the finest collections of North American birds in existence, and in pursuit of the specimens which it contains Colonel Goss visited many sections of the United States, British America, Mexico, and Central America.

Colonel Goss was an active member of the Kansas Academy of Science and a frequent contributor to its transactions. His papers related mostly to the ornithology of Kansas. He also was a frequent contributor to *The Auk*, the organ of the American Ornithologists' Union, of which he was one of the founders and a life member. He prepared two catalogues of the birds of Kansas, which were published by the state. His chief work was the large octavo "History of the Birds of Kansas," published but a few days before his sudden death, which occurred at Neosho Falls, March 10, 1891.

Colonel Goss had a host of personal friends and no enemies, but there were few whom he admitted to the circle that might claim intimacy with him. It was only these few who could properly appreciate the sterling worth and sincerity of the man. To others he was friendly and courteous, but he gave them no insight into his inner life. He was a man of rare powers of observation, and his judgment of men was not often at fault. In his death the state lost a most valuable citizen, and the cause of science a firm friend.

DR. GEO. T. FAIRCHILD.

GEORGE THOMPSON FAIRCHILD was born in Brownhelm, Lorain county, Ohio, October 6, 1838. He was the youngest of eight children; was educated at Oberlin College, graduating from the classical course in 1862, and from the theological department in 1865. He was ordained to the ministry of the Congregational church, but was never a pastor. In 1865 he was elected an instructor in the Michigan State Agricultural College, and in the following year was appointed as professor of English literature. After nearly fourteen years in this position, he resigned it to accept the presidency of the Kansas State Agricultural College, to which place he was elected in 1879. He brought to his work in Kansas a ripe scholarship and such a clear appreciation of the true scope of agricultural education that he became the ideal president for such an institution. He was a man of great energy, of sound judgment in business affairs, and of experience in educational work. He had that love and respect for scientific truth that enabled him properly to appreciate the great importance of science as the foundation of all successful agriculture. While he never dictated methods to his associates in the faculty of the college, but left them unhampered, he stimulated each to do his best within his sphere, and held him to strict account as to results.

His retirement from the presidency of the college in 1897, the result of political change in the state, was a great misfortune to Kansas. But his eighteen years of faithful service, poorly paid for, as such services usually are, were of great benefit in molding character and in impressing high ideals of life and service, which will have lasting effect in the state. After a year of retirement from teaching, during which Doctor Fairchild wrote "Rural Wealth and Welfare," published by McMillan & Co. in their Rural Science series, he was called to the vice-presidency and chair of English literature in Berea College, Kentucky, a position which he held until his death. This event occurred, after a protracted illness and a severe surgical operation, in a hospital at Columbus, Ohio, March 16, 1901.

Doctor Fairchild had been for some time an annual member of the Kansas Academy of Science, and had taken a deep interest in its work. While not himself absorbed in any scientific pursuit, he encouraged scientific investigation in every way possible, and recognized its importance to the work in which he was engaged; and it was fitting that after his removal from the state the Academy should recognize

his friendly spirit toward his work by electing him to honorary membership. This was done at the holiday meeting of two years ago; but disease had already laid its hand upon him and he was too weak to acknowledge the receipt of the secretary's notice of his election. By his death the cause of science and the cause of education both sustained a great loss. His was a personality and character whose good influence was impressed upon thousands of young lives in Michigan, in Kansas, and in the whole country, and his early death was a cause for sincere regret.

DAVIS A. BOYLES.

DAVIS A. BOYLES was born in Saline county, Kansas, August 17, 1872, and died at Salina, July 9, 1902. Most of his life was spent in Salina and near that place. He was an enthusiastic naturalist, and was a scholarly gentleman. He was a teacher in the schools of Salina, and had at times acted as assistant to Prof. A. W. Jones, at the Salina Wesleyan University. He was married in May of 1902, and besides his young wife, he leaves a mother, father, and a brother. He was elected an active member of the Kansas Academy of Science at the McPherson meeting, December 29, 1899.

VII.

APPENDIX.

ACCESSIONS TO THE ACADEMY LIBRARY, 1901 and 1902.

GENERAL INDEX TO THE ACADEMY TRANSACTIONS, 1872 to 1900.

INDEX TO VOLUME XVIII (1903).

ADVERTISEMENT OF VOLUMES ISSUED BY THE ACADEMY.

ANNOUNCEMENTS BY THE SECRETARY.

ADDITIONS TO LIST OF MEMBERS.

APPENDIX.

ACCESSIONS TO THE LIBRARY.

JANUARY 1, 1901, TO DECEMBER 31, 1902.

In moving the Academy library into new and permanent quarters, the accession list for 1901 was lost, and the present list is made as nearly complete as possible.

CALIFORNIA.

BERKELEY.
University of California:
Bulletins of the Department of Geology, vol. II, Nos. 8 to 12 (1901); vol. III, Nos. 1 to 6, 1902.

LOS ANGELES.
The West American Scientist:
Vol. 13, No. 4, 1902.

SAN FRANCISCO.
California Academy of Sciences:
Proceedings, third series, 1901-'02.
Botany, vol. II, Nos. 1 to 11.
Zoology, vol. II, Nos. 7 to 11; vol. III, Nos. 1 to 4.

STANFORD UNIVERSITY.
Contributions to Biology from the Hopkins Seaside Laboratory:
Articles XXIII-XXVIII, 1901-'02.

COLORADO.

BOULDER.
University of Colorado:
Studies, vol. I, No. 1, 1902.

COLORADO SPRINGS.
Colorado College:
Studies, vol. IX.

DENVER.
Colorado Scientific Society:
Proceedings, vol. VI, 1897-1900; vol. VII, pp. 1 to 40.

DISTRICT OF COLUMBIA.

WASHINGTON.
Biological Society of Washington:
Proceedings, vol. 14; vol. 15, pp. 1 to 250, 1902.
Charles W. Smiley, publisher:
The American Monthly Microscopical Journal, vol. 22, 1901; vol. 23, seven numbers, 1902.
United States Department of Agriculture:
Annual Report of Secretary for 1901-'02.
Year Book, 1901.
Index to Year Books, 1894-1900.
Bulletins, Circulars and Reports for 1901-'02, from the following divisions: Agrostology, Animal Industry, Biological Survey, Botany, Chemistry, Entomology, Experiment Stations, Foreign Markets, Forestry, Plant Industry, Publications, Soils, Weather Bureau, Irrigation Experiments.
United States Department of the Interior:
United States Geological Survey.
Nineteenth Annual Report, seven parts, 1897-'98.
Twentieth Annual Report, seven parts, 1898-'99.
Annual Report, parts, 1899-1900.

WASHINGTON.
United States Department of the Interior:
Monographs, vol. XXXIX, 283 pp.; XL, 148 pp.; XLI, 802 pp.
Bulletins 163-194, 1901-'02.
Two special papers on Alaska.
Smithsonian Institution:
Annual Reports, 1900-'01.
Smithsonian Miscellaneous Collections, vol. XLI.
Contributions to Knowledge.
Experiments with Ionized Air, 1901.
Bureau of Ethnology:
Annual Report, vol. 19, in two parts, 1159 pp., 1897-'98.
United States Navy Department:
Report of Superintendent of Naval Observatory, 1901.
United States Coast and Geodetic Survey:
Annual Report, 1900.

ILLINOIS.

CHICAGO.
Armour Institute of Technology:
Year Books, 1901-'02, 1902-'03.
Chicago Academy of Sciences:
Bulletin, vol. II, No. 4, 1902.
Field Columbian Museum:
Anthropological series, vol. 3, Nos. 1, 2, 3.
Botanical series, vol. 1, No. 7, and index.
Geological series, vol. 1, No. 11.
Zoological series, vol. 3, Nos. 6, 7.
Library Bureau:
Public Libraries (monthly), vol. 6, vol. 7, 1902.
University of Chicago:
Department of Geology, Journal of Geology, vols. 9, 10, 1901 02.

ROCK ISLAND.
Augustana Library Publications, 1900, No. 3, 1902.

URBANA.
Illinois State Laboratory of Natural History:
Bulletin, vol. VI, part 1.

INDIANA.

INDIANAPOLIS.
Indiana Academy of Science:
Proceedings, 1901.

IOWA.

DAVENPORT.
Davenport Academy of Sciences:
Proceedings, 1901.

DES MOINES.
Iowa Geological Survey:
Vol. XII.

KANSAS.

LAWRENCE.
University of Kansas:
The Kansas University Quarterly, vol. X, four numbers, 1901.
University Geological Survey:
Vol. VII, Mineral Waters.
Mineral Resources for 1899, 1900-'01.

MANHATTAN.
Agricultural College:
Bulletins, Nos. 99-114.
Annual Reports, 13, 14, 15.
The Industrialist, vols. 27, 28, 1901-'02.

TOPEKA.
Reports of the various state departments for 1901.

MAINE.

AUGUSTA.
State Board of Agriculture:
Reports, vol. I, No. 1, 1902.

PORTLAND.
Portland Society of Natural History:
Proceedings, vol. II, parts 3, 4, 5.

MARYLAND.

BALTIMORE.
Johns Hopkins University:
Circulars, Nos. 149-160, 1901-'02.
Maryland Geological Survey:
Vols. III, IV.

MASSACHUSETTS.

BOSTON.
American Academy of Arts and Sciences:
Proceedings, vol. 37 (1901-'02); vol. 38, Nos. 1 to 9 (1902).
Boston Society of Natural History:
Proceedings, vol. XXX, Nos. 1 to 7.
Massachusetts Horticultural Society:
Transactions for 1900, for 1901, two parts.

CAMBRIDGE.
Museum of Comparative Zoology at Harvard College:
Annual Reports, 1900-'01, 1901-'02.
Bulletins, vol. 37, No. 23; vol. 39, Nos. 1, 2, 3; vol. 40, Nos. 1, 2; vol. 41, No.

TUFTS COLLEGE.
Tufts College Studies, No. 7.

MICHIGAN.

LANSING.
Michigan Geological Survey:
Annual Report, 1901.

MINNESOTA.

MINNEAPOLIS:
University of Minnesota Agricultural Experiment Station:
Bulletins, Nos. 69 to 72.
Minnesota Academy of Natural Sciences:
Bulletin, vol. 3, No. 3.

MISSOURI.

COLUMBIA.
University of Missouri:
Studies, vol. I, Nos. 2, 3, 4,; vol. III, No. 10.

ST. LOUIS.
Academy of Sciences of St. Louis:
Transactions, vol. 12, Nos. 1 to 9.
Missouri Botanical Garden:
Annual Reports, vol. 12, 165 pp., 47 plates; vol. 13, 133 pp., 99 plates, 1902.

MONTANA.

MISSOULA.
University of Montana:
Bulletin No. 3, Summer Birds of Flathead Lake.

NEBRASKA.

LINCOLN.
University of Nebraska:
Graduate Bulletins, series 6, No. 3; series 7, No. 3.

NEW JERSEY.

TRENTON.
State Geological Survey:
Report for 1901.

NEW YORK.

BUFFALO.
Grosvenor Library:
Catalogue of Books on Latin America, 1901.
Catalogue of Poetry in English Language, 1902.

BROOKLYN.
Museum of Brooklyn Institute of Arts and Sciences:
Vol. 1, No. 1, 1901.

HAMILTON.
Colgate University, Department of Geology:
Circular for 1901-'02.

NEW BRIGHTON.
Natural Science Association of Staten Island:
Proceedings, vol. 8, Nos. 1 to 17.

NEW YORK.
New York Academy of Sciences:
Annals, vol. 14, parts 1, 2.
Memoirs, quarto, vol. II, parts 1, 2, 3.
New York Botanical Garden:
Bulletin, vol. 2, Nos. 6, 7, 15; vol. 3, No. 32.
Journal, vol. II, No. 15 (1901); vol. III, No. 32 (1902).
Hyde Exploring Expedition:
The Papoose, December, 1902.
The Electrical Review:
Vols. 37-41, 1901-'02.

ROCHESTER.
Rochester Academy of Sciences:
Proceedings, vol. III, parts 1, 2, 3, 4; vol. IV, pp. 1 to 64, 1901.

OHIO.

CINCINNATI.
C. G. Lloyd:
Mycological Notes, 5, 6, 7, 8 (1901).
Historical and Philosophical Society of Ohio:
Annual Report for 1901.
Lloyd Library:
Bulletins, Reproductive series, No. 2; Pharmacy series, No. 1; Mycological series, No. 1.
Cincinnati Museum Association:
Annual Reports, 21, 1901.

CLEVELAND.
Western Reserve Historical Society:
Vol. IV, Tracts 89, 90, 1901.

COLUMBUS.
Ohio Academy of Science:
Annual Reports, 9, 10, 1901-'02.
Special papers, No. 4, The Fishes of Ohio, 1901.
Ohio Archæological and Historical Society:
Quarterly, vol. 11, Nos. 1, 2.
Annual Report for 1901.
Ohio State University Naturalist:
Vols. I, II, 1901-'02.
Ohio State University, Department of Zoology and Entomology:
Bulletins, Nos. 6, 7, 8, 1901-'02.
Journal of Mycology:
Vol. 8, Nos. 61-64, 1902.

GRANVILLE.
Denison University:
Bulletin of the Scientific Laboratories, vol. 12, Nos. 1 to 4; Memoirs, vol. I, No. 1.

WOOSTER.
Ohio Agricultural Experiment Station:
Bulletins, Nos. 123 to 133, 1901-'02.

PENNSYLVANIA.

PHILADELPHIA.
Academy of Natural Sciences of Philadelphia:
Proceedings for the years 1899, 1901, 1902; vol. 54, parts 1, 2, 1902.
American Philosophical Society:
Proceedings, vol. 40, Nos. 165-167, 1901-'02; vol. 41, Nos. 168-170.
Transactions, vol. XX, parts 1, 2, 3, 1899-1902.
Henry Kraemer, author:
On Continuity of Protoplasm.
The Structure of the Starch Grain.
Numismatic and Antiquarian Society:
Proceedings for years 1899-1901.
University of Pennsylvania:
Free Museum of Science and Art, Bulletins, vol. 3, four parts, 1901.

PITTSBURG.
Carnegie Institute:
The Fifth Annual Celebration of Founder's Day.
Carnegie Museum:
Publications, Nos. 6, 7.

WILKESBARRE.
Wyoming Historical and Geological Society:
Proceedings and Collections, vol. V, 1900; vol. VI, 1901; vol. VII, 1902.

RHODE ISLAND.

NEWPORT.
Natural History Society:
Proceedings, 1891-'99.

SOUTH DAKOTA.

DEADWOOD.
George Walter Hale, author:
Earthquakes, their Origin and Phenomena.

TENNESSEE.

KNOXVILLE.
University of Tennessee:
Record, vol. 4, six numbers; vol. 5, five numbers, 1902.

TEXAS.

AUSTIN.
Texas Academy of Science:
Transactions, vol. 4, parts I, II, Nos. 1, 2, 3, 1902.
University of Texas Mineral Survey:
Bulletins 3, 4, 1902.

VERMONT.

BURLINGTON.
State Agricultural College:
Bulletins 85-92, 1901-'02.

WASHINGTON.

OLYMPIA.
State Geological Survey:
Vol. 1, 1901.

SPOKANE.
L. K. Armstrong, publisher:
Mining, a monthly magazine, vols. 6, 7, 8, 9, 10, 1900-'02.

WISCONSIN.

MADISON.
- Wisconsin Academy of Sciences, Arts, and Letters:
  - Transactions, vol. 13, part 1, 1900.
- Geological and Natural History Survey:
  - Bulletins, Economic series, No. 4, The Clays and Clay Industries of Wisconsin.

MILWAUKEE.
- Public Museum of the City of Milwaukee:
  - Annual Reports, 19, 20.
- Wisconsin Natural History Society:
  - Bulletin, vol. II, Nos. 1, 2, 3.

CANADA.

HALIFAX, N. S.
- Nova Scotia Institute of Natural Science:
  - Proceedings and Transactions, vol. X, parts 3, 1900-'01.
  - Report of Department of Mines, 1898-1900.

HAMILTON.
- Hamilton Association:
  - Journal and Proceedings, vols. 16, 17, 18, 1900-'02.

MONTREAL, QUEBEC.
- Natural History Society of Montreal:
  - Canadian Record of Science, vol. VIII, parts 6, 7, 8, 1902.
  - Numismatic and Antiquarian Society, vol. 4, No. 1, 1902.

OTTAWA, ONTARIO.
- Department of Agriculture:
  - Statistical Year Book, 1901.
- Geological and Natural History Survey of Canada:
  - General Index to Reports of Progress, 1863-'84.
  - Catalogue of the Marine Invertebrata of Eastern Canada, 1901.
- Ottawa Field Naturalists' Club:
  - Ottawa Naturalist, vols. 15, 16, 1901-'02.

QUEBEC, QUEBEC.
- V. A. Huard, publisher:
  - Le Naturaliste Canadien, vols. 28, 29, 1901-'02.

TORONTO, ONTARIO.
- Canadian Institute:
  - Transactions, vol. VII, part 1, 1901.
- Caswell Company, publishers:
  - Catalogue of Canadian Publications, 1902.

MEXICO.

MEXICO CITY.
- Instituto Geologico de Mexico:
  - Boletin, 15, 1901.
- Observatorio Meteorologico Magnetico Central:
  - Boletins, 1900, January to October, 1901.
  - Observations during the Eclipse of May 28, 1900, Text and Atlas.
- Sociedad Cientifica "Antonio Alzate":
  - Memorias y Revista, tomos XV, Nos. 6 to 12, 1901; XVI, six Nos.; XVII, three Nos., 1902.
- Sociedad de Agricultura, Mineria e Industrias:
  - Boletin, ano XI, XII.
- Data referring to Mexican Mining, 1901, prepared for Paris Exposition, by Carlos Sellerier.

WEST INDIES.

KINGSTON, JAMAICA.
- Botanical Gardens:
  - Bulletins, vols. 8, 9, 1901-'02.
- Board of Agriculture:
  - First Report, 1901.
- Report of Public Gardens, 1900, 1901.

SOUTH AMERICA.

ARGENTINA.

BUENOS AIRES.
Museo Nacional:
Anales, t. VII, 1902; Comunicaciones, vol. 1, Nos. 1 to 10, 1901.
Sociedad Cientifica Argentina:
Anales, t. 51, 52, 53, 54, three parts (1902); Index to vols. 1 to 40.

LA PLATA.
Dr. Florentino Ameghino:
Special papers.
Museo de la Plata:
Revista, t. X, 1902.

BRAZIL.

PARA.
Museo Paraense de Historia Natural:
Boletin, vol. III, part 2, 1901.

RIO DE JANEIRO.
Sociedad do Geographia:
Revista, t. XIV, 1901.

CHILE.

SANTIAGO.
Societe Scientifique du Chili:
Actes, tome XI, 1901-'02.

SOUTH AFRICA.

The First Report of Geological Survey of Natal and Zululand, 1901.

AUSTRALIA.

BRISBANE, QUEENSLAND.
Royal Society of Queensland:
Proceedings, vols. XVI, XVII, 1901.

MELBOURNE, VICTORIA.
Geological Survey of Victoria:
Geological Reports, 1900.

SYDNEY, NEW SOUTH WALES.
Department of Mines and Agriculture:
Annual Reports, 1901.
Mineral Resources, 1901.
Records of the Geological Survey, vols. II to VII.

EUROPE.

AUSTRO-HUNGARY.

BRUNN, MORAVIA.
Naturforschende Verein:
Verhandlungen, bands XXXVIII, XXXIX, 1899-1900.
Bericht der Meteorologischen Commission, XVIII, 1898; XIX, 1899.

BUDAPEST, HUNGARY.
Magyarboni Foldtani Tarsulat (Hungarian Geological Society):
Foldtani Kozlony, XXXI, XXXII, 1901-'02.
Royal Hungarian Society of Natural Sciences:
Erdmagnetische Messungen in den Landen der Ungarischen Krone, years 1892-'94.

GRAZ, STYRIA.
Franz H. Ascher, editor:
Montan-Zeitung, semimonthly, 1901-'02.

PRAG, BOHEMIA.
K. bohmische Gesellschaft der Wissenschaften:
Sitzungsberichte, 1901; Jahresbericht, 1901.

WIEN, AUSTRIA.
K. Akademie der Wissenschaften:
Vols. 15 to 17, 1901-'02.
Naturwissenschaftlicher Verein:
Sitzungsberichte, 1901-'02.

BELGIUM.

BRUXELLES.
Societe Belge de Geologie, de Paleontologie, et de Hydrologie:
Bulletins, tomes XV, XVI, 1901-'02.
Societe Royale Linneenne de Bruxelles:
Bulletin, monthly, 1901-'02.

LIEGE.
Societe Geologique de Belgique:
Bulletin, tome XXVII, 1900.

FRANCE.

BORDEAUX.
Societe Linneenne de Bordeaux:
Proces Verbaux, vols. LV, LVI, 1901-'02.

CAEN.
Academie Nationale des Sciences, Arts, et Belles Lettres:
Memoires, 1900-'01.
Societe Linneenne de Normandie:
Bulletin, series 5, vols. III, IV, 1900-'01.

CHERBOURG.
Societe Nationale des Sciences Naturelles:
Memoires, t. XXXII, 1901-'02.

HAVRE.
Societe Havraise d'Etudes Diverses:
Recueil, 1900, parts 3, 4; 1901, parts 1, 2, 3; L'Abeille Havraise, 1901.

MARSEILLES.
Societe de Horticulture et de Botanique:
Revue Horticole, an. 1901-'02.

MONTPELIER.
Academie des Sciences:
Memoires, tome III, No. 1, 1901.

PARIS.
Museum d'Histoire Naturelle:
Bulletins, 1901-'02, parts 1, 2, 3.
Societe d'Ethnographie:
Bulletins, Nos. 128 to 130, 1901.
J. B. Bailliere & Fils:
Bulletin Mensual; Le Mois Medico-chirurgical; Librarie, 1901-'02.
Niederlein Gustavo (Philadelphia, U. S. A.), author:
Resources Vegetales des Colonies Francaises.

TOULOUSE.
Academie des Sciences, Inscriptions, et Belles Lettres:
Memoires, 10th series, vol. I, 1901.
Societe de Geographie de Toulouse:
Bulletin, 1900, Nos. 5, 6; vol. XX, six numbers, 1901.
Congress de Geographie de Nancy:
Unification des Mesures Angulaires, from the author, J. de Ray-Pailhade.

LUXEMBOURG.
Institut Grand Ducal de Luxembourg:
Sec. des Sci. Nat. et Mathematiques, vol. 35.

GERMANY.

BERLIN, PRUSSIA.
Berliner Entomologischer Verein:
Zeitschrift, XLVI, parts 2, 3, 4, 1901.

BONN, PRUSSIA.
Naturhistorischer Verein der Preussischen Rheinlande und Westfalens:
Verhandlunges, Jahrgang, 58, 1901.
Niederrheinischer Gesellschaft fur Natur und Heilkunde zu Bonn:
Sitzungsberichte, 1901.

BREMEN, GERMANY.
Naturwissenschaftliche Verein:
Abhandlungen, band XVII, heft 1, 1901.

DRESDEN, SAXONY.
Naturwissenschaftliche Gesellschaft "Isis":
Sitzungsberichte und Abhandlungen, Jahrgang 1901 to June, 1902.

FRANKFURT-AM-ODER.
Naturwissenschaftliche Verein des Regierungs-Bezirks Frankfurt:
Helios, band XIX, 1901; XX, 1902.

GIESSEN, HESSE.
Oberhessische Gesellschaft fur Natur und Heilkunde:
Berichte, 33, 1899–1902.

GORLITZ, SAXONY.
Naturforschende Gesellschaft:
Abhandlungen XXIII, 1901.

HALLE-AN-DER-SAALE.
Geschichte der Bibliothek und Naturaliensammlung, von Dr. Oscar Gurlich:
Bibliothekar (1894), received 1901.
Kaiserliche Leopoldinisch-Carolinische Deutsche Akademie der Naturforscher:
Leopoldina XXXVI, 1900: Repertorium, 1 to 53 volumes; Geschichte, 1832–'87.
Naturwissenschaftliche Verein fur Sachsen und Thuringen:
Zeitschrift fur Naturwissenschaften, banden 73, parts 3, 4, 1900; 74, parts 1, 2, 3, 4, 1901.

HAMBURG, GERMANY.
Naturwissenschaftliche Verein in Hamburg:
Abhandlungen, IX; Verhandlungen, band XVI, 1901.

KIEL, PRUSSIA.
Naturwissenschaftliche Verein fur Schleswig-Holstein:
Schriften, band XII, 1901.

LEIPZIG, SAXONY.
Koniglich-Sachsiche Gesellschaft der Wissenschaften:
Berichte, 53, 1901, 54, parts 1, 2, 1902.

MAGDEBURG, SAXONY.
Naturwissenschaftliche Verein:
Jahresbericht und Abhandlungen, 1900–'02.

MUNSTER, PRUSSIA.
Westfalische Provinzial-Verein fur Wissenschaft und Kunst:
Jahresbericht, XXVIII, 1900.

OFFENBACH, BADEN.
Verein fur Naturkunde:
Bericht, 37–42, 1901.

OSNABRUCH, PRUSSIA.
Naturwissenschaftlicher Verein:
Jahresbericht fur 1899, 1900.

REGENSBURG, BAVARIA.
Naturwissenschaftliche Verein zu Regensburg:
Berichte, VIII, 1901.

WEISBADEN, PRUSSIA.
Nassauischer Verein fur Naturkunde:
Jahrbucher, 54, 1901.

GREAT BRITAIN.

BELFAST, IRELAND.
Natural History and Philosophical Society:
Reports and Proceedings, sessions 1901-'02.

DUBLIN, IRELAND.
Royal Dublin Society:
Scientific Transactions, vol. VII, 188, 1901.

GLASGOW, SCOTLAND.
Philosophical Society:
Proceedings, vols. 32, 1900-'01; 33, 1901-'02.

LIVERPOOL.
Liverpool Geological Society:
Proceedings, vol. IX, part 1, 1901.

LONDON.
Geological Society of London:
Abstracts, 1900-'02.

MANCHESTER.
Literary and Philosophical Society:
Memoirs and Proceedings, XLV, XLVI, 1900-'02.

PENZANCE.
Royal Geological Society of Cornwall:
Transactions, vol. VII, 1902.

HOLLAND.

HELDER.
Nederlandsche Dierkundige Vereeniging:
Tijdschrift, deel VII, parts 1 to 4; Catalogus der Bibliotheek, February, 1901, December, 1902.

LIEDEN.
Nederlandsche Entomologische Vereeniging:
Vol. VII, four parts, 1901-'02.

ITALY.

CATANIA.
Accademia Gioenia de Scienze Naturali:
Bolletino delle Sedute, fasc, LXX-LXXIII, 1901 (April, 1902).

GENOVA (Genoa).
Societa Ligure di Storia Patria:
Atti, XXIX-XXXIII, 1898-1901.

MILANO.
Societa Italiana di Scienze Naturali:
Atti, vol. XLI, parts 1, 2, 3, 1902.

PADOVA (Padua).
R. Accademia di Scienze, Lettere, et Arti;
Atti e Memorie, XVII, 1900-'01.
Indice Generale, vols. 12-15, 1901.

PALERMO.
R. Accademia di Scienze:
Contribuzioni alla Biologia Vegetale, vol. III, part 1, 1902.

PISA.
Societa Toscana di Scienze Naturali:
Processi Verbali, vol. XIII, three numbers.

ROMA.
Accademia Pontificia di Nuovi Lincei:
Atti, LIV, 1901, LV, to June, 1902.

SIENA.
Rivista Italiana di Scienze Naturali:
Bulletino, anni XXI, XXII, 1901, 1902.
Rivista, anni XXI, XXII, six numbers, 1901-'02.

TORINO.
Accademia Reale delle Scienze:
Atti, XXXVI, 1900-'01; XXXVII, 1901-'02.

NORWAY.

CHRISTIANA.

Videnskabs Selskabet i Christiana:
Forhandlinger for 1900, 1901.

STAVANGER.

Stavanger Museum:
Arsberetning, 1900, 1901.

TRONDHJEM.

Kongelige Norske Videnskabers Selskab (Royal Norwegian Society of Sciences):
Skrifter, 1900.

RUSSIA.

HELSINGFORS, FINLAND.

Finska Vetenskaps Societeten (Scientific Society of Fiuland):
Ofversigt, XLIII, 1900-'01.

Geological Commission—Bulletin de la Commission Geologique de Finlande:
Nos. 12, 13, 1902.

Societas pro Fauna et Flora Fennica:
Acta, vols. XVIII, XIX, XX, No. 1, 1899-1902.

KASAN.

Societe Physico-mathematique de Kasan:
Bulletin, tome X, Nos. 2, 3, 4, 1900.

NEW ALEXANDRIA.

N. Krishtafovich:
Annuaire Geologique et Mineralogique de la Russie, vol. III, part 10, 1900; vol. IV; vol. V, parts 1, 2, 3, 1901.

ST. PETERSBURG.

La Comite Geologique a l'Institut des Mines:
Bulletins XIX. parts 7 to 10, 1900; vol. XX, six parts, 1901; Memoirs, vol. XVIII, Nos. 1, 2, 1901.

Imperial Mineralogical Society:
Contributions to Russian Geology; Transactions, vol. XXXIX, 1901.

SPAIN.

BARCELONA.

Academia de Ciencias y Artes:
Boletin, vol. II, parts 1 to 4, 1901.
Memoirs, vol. III, Nos. 1 to 25, 1901; vol. IV, Nos. 1 to 27, 1902.
Nomina del Personal Academico, 1900-'01, 1901-'02.

SWEDEN.

STOCKHOLM.

Entomologiska Foreningen i Stockholm:
Entomologisk Tidskrift, for 1901.

K. Svenskaps Akademien (Royal Swedish Academy of Sciences):
Bihang, vol. XXVI, 1901.

UPSALA.

Kongliga Upsala Universetet:
Arsskrift, 1901.

SWITZERLAND.

BASEL.

Naturforschende Gesellschaft in Basel:
Verhandlungen, banden XIII, 1901-'02; XIV, 1901.
Namenverzeichnis und Sachregister der Bande, six bis twelve, 1875-1900 (1901).

BERN.

Naturforschende Gesellschaft:
Mittheilungen, Nos. 1478-1499, 1901; Nos. 1500-1518, 1902.

GENEVA.

Societe de Physique et d'Histoire Naturelle:
Compte Rendu, vol. XVIII, 1901.

NEUCHATEL.

Societe des Sciences Naturelles:
Bulletin, tome XXVII, 1898-'99.

Societe Neuchateloise de Geographie:
Bulletin, tome XIV, 1902.

SAINT GALL.

Saint Gallische Naturwissenschaftliche Gesellschaft:
Bericht, 1899-1900.

GENERAL INDEX

TO THE

TRANSACTIONS OF THE ACADEMY,

Vols. I-XVII, 1872-1900.

COMPILED BY G. P. GRIMSLEY, SECRETARY.

The following index includes subjects, authors, and publications; covers 2500 pages, in 17 volumes, and contains a list of 534 articles and 140 contributors.

SUBJECTS.

(Figures in parentheses refer to pages in reprint of vols. I-III.)

Aborigines, traces of, in Riley county. G. H. Failyer ..... VII, 132
Absorption, selective, of heat by leaves. A. G. Mayer ..... XIII, 48
Academy of Science, history and growth. D. E. Lantz ..... XVI, 24
Acetic acid, diluted, as a solvent for extractive substances. L. E. Sayre ..... XIV, 44
Æcidium, new, of peculiar habit. M. A. Carleton ..... XIV, 44
Age of Kansas (illustrated). B. B. Smyth ..... IX, 129
Agricultural products, analysis of. J. T. Willard ..... XII, 21
Albuminoids, a study of. L. E. Sayre ..... XII, 16
Alcohols, different, relative sweetness of. E. E. Slosson ..... XII, 104
Alkyl hypobromites. F. W. Bushong ..... XV, 81
Alum, feather, from Colorado. E. H. S. Bailey ..... XII, 101
Amblychila cylindriformis. F. H. Snow ..... VI, 29
Americus limestone (illustrated). A. J. Smith ..... XVII, 189
Amethyst mountain, christening of. Joseph Savage ..... IX, 105
Ampelopsis quinquefolia, variety of. E. B. Knerr ..... XIII, 69
Anemometers, comparison of records of two at University of Kansas. F. H. Snow, XI, 107
Animal ethics. A. H. Thompson ..... XI, 52
Antennæ, observations on their use in Polyphilla variolosa. F. H. Snow ..... III, 27 (128)
Antrostomus carolinensis. R. Matthews ..... XVI, 277
Ants, red, note on a habit of. Robert Hay ..... X, 27
Apparatus, new, for continuous extraction of solids by a volatile solvent (illustrated). J. T. Willard and G. H. Failyer ..... X, 20
Archæology of Catalina island. J. R. Mead ..... XVII, 215
Archæological notes (illustrated). G. S. Chase ..... IX, 30
Arkansas, geology of the Arkansas. B. F. Mudge ..... I, 408 (50)
Arkansas river, a dying river. J. R. Mead ..... XIV, 111
Artesian well, Fort Scott, the water of. E. H. S. Bailey ..... IX, 96
Artesian wells, Kansas, and the causes of their flow. Robert Hay ..... XII, 24
Artesian wells, Muscotah. E. B. Knerr ..... XVII, 53
Artist, what is good for an artist and what is an artist good for? Lizzie J. Williams ..... I, 411 (54)
Atchison diamond-drill prospect hole (illustrated). A. E. Langworthy ..... XVII, 45
Atchison rock exposures (illustrated). J. M. Price, jr ..... XIV, 218

Barite and associated minerals in concretionary rocks of eastern Kansas. E. H. S. Bailey and E. E. Slosson ..... XII, 45
Barite nodules in wood. E. B. Knerr ..... XV, 80
Barite, pink, from Atchison limestone. E. B. Knerr ..... XIII, 76
Beetle, the cottonwood-leaf beetle. W. Osburn ..... IV, 24

Beetles, habits of Amblychila cylindriformis (illustrated). H. A. Brous..... V, 11
Beetles (see, also, Coleoptera).
Belvidere, Kan., and vicinity, its natural-history possibilities. C. N. Gould..... XVI, 283
Bending moments, maximum, for moving loads in a draw-beam. E. C. Murphy.. XIII, 116
Bibliography of Kansas geology (1894). Robert Hay..... XIV, 261
Binding-twine and its manufacture. L. E. Sayre..... XII, 19
Birds, the anhinga. N. S. Goss..... XI, 58
Birds, Kansas, catalogue of birds of Kansas. F. H. Snow..... I, 375 (21)
—— —— —— additions in 1874. F. H. Snow..... III, 30 (133)
—— —— —— additions in 1878. F. H. Snow..... VI, 38
—— —— new to the fauna of Kansas and birds rare in the state. N. S. Goss..... IX, 26
—— —— —— additions in 1885. N. S. Goss..... X, 28
—— —— —— additions in 1886. N. S. Goss..... X, 77
—— —— —— additions in 1888. N. S. Goss..... XI, 60
—— three new Kansas birds. F. H. Snow..... XI, 62
—— —— —— additions in 1889. N. S. Goss..... XII, 24
—— —— revised catalogue (correction). N. S. Goss..... XII, 60
—— —— —— additions in 1896. V. L. Kellogg..... XV, 15
—— —— Ictinia mississippiensis and Ægialitis nivosa nesting in south-central Kansas. N. S. Goss..... XI, 11
—— —— Dickinson county, list of birds seen, 1898 to 1900. D. E. Lantz..... XVII, 116
—— —— annotated list of birds found near Manhattan. D. E. Lantz..... XIV, 115
—— list of, collected by Col. N. S. Goss in Mexico and Central America. D. E. Lantz..... XVI, 218
—— —— of southern Kansas, some notes on. J. R. Mead..... XVI, 216
—— —— two rare forms in Kansas. A. M. Collette..... XIII, 29
—— summer, of Estes Park, Colorado. V. L. Kellogg..... XII, 86
Bird-track, fossil, in Dakota sandstone (illustrated). F. H. Snow..... X, 3
Bison, note on the fossil jaw of bison from Pliocene of Norton county. Robt. Hay, IX, 98
Bison latifrons in Kansas. B. F. Mudge..... V, 9
Bitterness, relative, of different bitter substances (illustrated). E. H. S. Bailey and E. C. Franklin..... X, 23
Black and white (illustrated). E. L. Nichols..... X, 37
Blooming, long continued, of Malvastrum coccineum. Minnie Reed..... XIV, 132
Bluffs, the river bluffs. Johns D. Parker..... V, 71
Botany (see, also, Plants).
—— report on botany of Kansas for 1873. J. H. Carruth..... II, 9 (74)
—— report for 1874. J. H. Carruth..... III, 23 (122)
Botanical addenda for 1878. J. H. Carruth..... VI, 40
—— —— for 1879 and 1880. J. H. Carruth..... VII, 123
—— —— for 1881 and 1882. J. H. Carruth..... VIII, 32
—— —— for 1883 and 1884. J. H. Carruth..... IX, 142
—— notes for 1889. J. H. Carruth..... XII, 43
—— —— from the Southwest and floral clock. B. B. Smyth..... VII, 50
Boulder belt, terminal, in Shawnee county (illustrated). B. B. Smyth..... XIV, 220
Brachiospongia (illustrated). H. C. Hovey..... III, 10 (111)
Bromides and iodides in the water of Independence artesian well. E. H. S. Bailey, X, 22
Burning fluids, testing of. H. E. Sadler..... IX, 39
Burrowing, destructive, in shale. O. C. Charlton..... XII, 75

Calamites. M. V. B. Knox..... IV, 17
Carboniferous, last submersion and emergence of southeastern Kansas. E. P. West..... IX, 106
Carruth, J. H., memorial of. E. H. S. Bailey and B. B. Smyth..... XV, 135
Cassique, yellow-tailed, notes on. N. S. Goss..... XI, 12
Cements, note on second setting of. B. J. Dalton and F. O. Marvin..... XII, 10
—— tests on cement manufactured in Kansas. E. C. Murphy..... XII, 12
Cephalopods, fossil, some new species (illustrated). Robert Hay..... XIII, 37
Chalk, Kansas. G. E. Patrick..... IV, 13
—— —— structure of. S. W. Williston..... XII, 100
Chalybeate water, analysis of the deposit from. E. C. Case..... XIV, 36
Chemical notes, miscellaneous. E. H. S. Bailey..... X, 62
Chemistry, organic and physiological. E. H. S. Bailey..... IX, 87
Chinch-bugs, experiments for the artificial dissemination of a contagious disease among chinch-bugs, 1889. F. H. Snow.....

Chinch-bug experiments, second paper, 1890. F. H. Snow..... XII, 119
Chrysophanus, description of a new species. W. H. Edwards..... VII, 69
Cicindelidæ, notes on the habits of some of the rarer forms. S. W. Williston..... VI, 32
Clays, analysis of. W. H. Saunders..... III, 7 (99)
Climate and brains. M. V. B. Knox..... V, 5
Climate of Kansas. F. H. Snow..... I, 397 (40)
Coal in Atchison county. E. B. Knerr..... XIV, 216
Coal-fields of Cherokee county (illustrated). Erasmus Haworth..... VIII, 7
Coal and illuminating gas, experiments on the relative heating power (illustrated). E. H. S. Bailey..... XVII, 35
Coals of Kansas. W. H. Saunders..... I, 387 (30)
—— —— composition of. E. H. S. Bailey..... XI, 46
—— —— evaporative power of. L. I. Blake..... XI, 42
Coal Measures of Kansas and Nebraska, correlation of. J. W. Beede..... XVI, 70
—— —— of Lyon county. D. S. Kelly..... X, 45
Coal-oil legislation. H. E. Sadler..... IX, 36
Coleoptera, Colorado, list of forms collected, 1876. F. H. Snow..... V, 15
—— —— list of forms collected, 1878. F. H. Snow..... VI, 75
—— Kansas, list of. E. A. Popenoe..... V, 21
—— —— additions to catalogue. E. A. Popenoe..... VI, 77
—— —— additions to list in 1881, 1882. F. H. Snow..... VIII, 58
—— —— additions to list in 1883, 1884. Warren Knaus..... IX, 57
—— —— additions to list in 1885, 1886. Warren Knaus..... X, 86
—— —— additions to list in 1895. Warren Knaus..... XV, 18
—— —— additions to list in 1899, 1900. Warren Knaus..... XVII, 109
—— —— collecting notes on. Warren Knaus..... XVI, 197
—— —— Douglas county, additions to list in 1879, 1880. F. H. Snow..... VII, 78
—— New Mexico, list of forms collected in Santa Fe canon. F. H. Snow..... VII, 70
—— —— —— collected in 1881, 1882. F. H. Snow..... VIII, 35
—— —— —— list of, and of Lepidoptera, collected in 1883, 1884. F. H. Snow..... IX, 65
—— some salt-marsh forms. Warren Knaus..... IX, 64
—— North American, description of some new species. J. L. Le Conte and G. H. Horn..... VII, 74
Color-blindness among Indians. L. I. Blake and W. S. Franklin..... XI, 105
—— —— and railway accidents. John Fee..... VII, 30
—— —— statistics on, among students at State Agricultural College. C. M. Breese, XI, 106
—— —— statistics on, in the University of Kansas. E. L. Nichols..... IX, 95
Comet "B," 1882, observations of. H. S. S. Smith..... VIII, 28
Comet tails, speculations in regard to. F. W. Bardwell..... II, 14 (79)
Concretions. E. B. Knerr..... XVI, 44
Cone in cone (an impure calcite). H. J. Harnly..... XV, 22
Conics, imaginary focal properties of. H. B. Newson..... XII, 84
—— the inverse of conics and conicoids from the center (illustrated). M. E. Rice, XIV, 14
Conorhinus sanguisugus (Texas bedbug), habits and life-history (illustrated) Bertha S. Kimball..... XIV, 128
Constitution and by-laws of Academy..... IX, 3; XVI, 11; XVII, 14
Copepoda, a contribution to history of the fresh-water forms (illustrated). F. W. Cragin..... VIII, 66
Cormorant, double-crested. N. S. Goss..... XI, 59
Corn-cobs, economic value of. E. H. S. Bailey..... XI, 49
Corn-root worm, notes on. S. J. Hunter..... XIII, 131
Correspondents of Academy, 1894..... XIV, 280
Cosmos, a theory of. E. B. Knerr..... XVII, 20
Crayfishes, Kansas, annotated catalogue. J. A. Harris..... XVII, 115
Cretaceous forests and their migrations. B. F. Mudge..... VI, 46
Cretaceous rocks, Kansas, eastern extension and formation of certain sand-hills. Robert Hay..... XIV, 227
Culinary utensils, composition of. E. H. S. Bailey..... IX, 29
Curators Academy, report of, 1894..... XIV, 278
Cuscuta glomerata, the union with its host (illustrated). W. C. Stevens..... XII, 163

Dakota Cretaceous of Kansas and Nebraska. C. N. Gould..... XVII, 122
Dakota, in the. Robert Hay..... IX, 109
Dakota sandstone in Washington county. H. W. Charles..... XVII, 194
Diatoms, methods of collecting, cleaning, and mounting. Gertrude Crotty..... XII, 81

Diatomaceæ, Kansas. G. H. Curtis ..... XVII, 67
—— of Reno county (illustrated). G. H. Curtis ..... XVII, 70
Differentials of the second and higher orders. E. Miller ..... XII, 65
Dinosaurs, American Jurassic. S. W. Williston ..... VI, 42
Diptera, tables of the families. S. W. Williston ..... X, 122
Divining-rod observations. E. A. Kilian ..... XI, 114
Duck, black, in Kansas. R. Matthews ..... XVII, 114

Ebullition, a class-room experiment on. E. L. Nichols ..... IX, 27
Ecology, brief outline of. A. S. Hitchcock ..... XVII, 28
Effingham ridge, preliminary report on its geology. J. W. Wilson ..... XV, 113
Electric-light wires' insulation resistance. L. L. Blake and H. Radcliffe ..... XII, 44
Elevations in Kansas, Atlantic *vs.* Pacific. H. V. Hinckley ..... X, 53
Elm-tree girdler (illustrated). P. J. Parrott ..... XVI, 200
Energy, all energy is kinetic. E. B. Knerr ..... XIII, 30
Equus beds, McPherson (illustrated). J. W. Beede ..... XV, 104
Erysipheæ of Riley county (illustrated). Lora L. Waters ..... XIV, 200
Erythroniums, propagation of. E. B. Knerr ..... XV, 73
Erythronium mesochoreum (n. sp.) E. B. Knerr ..... XIII, 20
Evolution, influence of food selection upon the evolution of animal life. A. H. Thompson ..... V, 65
—— in leaves (illustrated). Mrs. W. A. Kellerman ..... XII, 168
Extractive yield of various important vegetable medicinal substances. L. E. Sayre ..... XIII, 120
Eye, human, the changes which occur in middle life. W. D. Bidwell ..... XI, 101

Face, human, origin and evolution of. A. H. Thompson ..... XIII, 6
Facial expression, descent of. A. H. Thompson ..... XIII, 122
—— —— its psychology. A. H. Thompson ..... XII, 67
Felis concolor. J. R. Mead ..... XVI, 278
Ferns of Wyandotte county. Minnie Reed ..... XIV, 150
Figurate series (illustrated). B. B. Smyth ..... XIV, 29
Fire-screen improvement. T. H. Dinsmore ..... XII, 81
Fish, food of, in central Kansas. G. H. Curtis ..... XVII, 75
Fishes, partial list of, in Marais des Cygnes at Ottawa. Wm. Wheeler ..... VI, 33
—— preliminary list of Kansas forms. I. D. Graham ..... IX, 69
—— rare forms of, in Kansas. B. F. Mudge ..... III, 22
Flint Hills of Kansas. J. R. Mead ..... XVII, 207
Flora, characteristic sand-hill flora. M. A. Carleton ..... XII, 32
—— composite, Kansas, relations of. A. S. Hitchcock ..... XIII, 89
—— Kansas, personal observations upon. Mrs. A. L. Slosson ..... XI, 19
—— preliminary notice of flora of Montgomery county. E. N. Plank ..... VIII, 133
—— provisional list of flowering plants of McPherson county. H. J. Haruly ..... XV, 75
—— gramineal, of Kansas (illustrated). F. L. Scribner ..... IX, 115
—— Kansas, additions to. B. B. Smyth ..... XII, 105
—— —— additions to. B. B. Smyth ..... XIII, 96
—— —— additions to, 1897.* B. B. Smyth ..... XV, 60
—— —— additions to. B. B. Smyth ..... XVI, 158
Floral horologe for Kansas (illustrated). B. B. Smyth ..... XVI, 106
Flowering plants and ferns, list of, in Franklin county. W. E. Castle ..... XIII, 80
Forests, evidence of ancient forests in central Kansas. H. C. Tower ..... V, 70
Forest-trees, Kansas, identified by leaves and fruit. W. A. Kellerman and Mrs. W. A. Kellerman ..... X, 99
Fossil footprints in Kansas, recent discoveries. B. F. Mudge ..... II, 7 (71)
—— note on a remarkable fossil. Robert Hay ..... X, 128
—— preliminary list of fossils found in Riley county. S. C. Mason ..... VIII, 12
—— wood. Robert Hay ..... VIII, 20
Fungi, partial list of Kansas parasitic fungi, together with their host-plants. W. A. Kellerman ..... IX, 79
—— —— —— —— second list. W. A. Kellerman and M. A. Carleton ..... X, 88
—— some of larger forms found in Blue river valley. Mrs. E. C. Jewell ..... VII, 131
Fusulina cylindrica, shell structure (illustrated). A. J. Smith ..... XVI, 64

Gastric juice, solubility of chrome yellow in. L. E. Sayre..... XI, 23
Geology, annual report of Academy committee for 1876. B. F. Mudge..... V, 4
—— of Kansas. Robert Hay..... XI, 35
—— report. Robert Hay..... X, 21
Geological survey of Kansas. B. F. Mudge..... III, 8 (101)
—— —— of the state, a necessity. R. J. Brown..... IX, 49
—— —— state, and its relation to work of the national survey. A. H. Thompson.... X, 9
—— work in Kansas, historical sketch. Robert Hay and A. H. Thompson..... X, 45
Germination of Indian corn after immersion in hot water. W. A. Kellerman..... XII, 134
Giants' Causeway and Fingal's Cave. C. D. Merrill..... VI, 6
Glaciated area of northeastern Kansas, some characteristics of. Robert Hay... XIII, 104
Glacial lakes, closing of. B. B. Smyth..... XV, 24
Glass mountains of western Oklahoma, geology of. Mark White..... XVII, 189
Gold in Montana. J. R. Mead..... XII, 5
Gophers, three species near Lawrence. L. L. Dyche..... XII, 29
Grasses, Kansas, an artificial key to. W. A. Kellerman..... XI, 87
—— —— (illustrated). A. S. Hitchcock..... XIV, 135
—— —— additions in 1897. A. S. Hitchcock..... XV, 59
Great Spirit spring (Waconda). G. E. Patrick..... VII, 22
Grebe, pied-billed, nesting of. A. M. Collette..... XIII, 49
Grebes, American, breeding habits of. N. S. Goss..... IX, 31
Guillemots, observations of nesting habits at Bird Rock. N. S. Goss..... VIII, 59
Gypsum cement plaster, chemical composition. E. H. S. Bailey..... XVI, 38
—— in Kansas. G. P. Grimsley..... XV, 122

Hackberry branch knot, distribution and ravages of (illustrated). W. A. Kellerman..... XII, 101
Harmonic forms (illustrated). B. B. Smyth..... XIV, 46
—— series, harmonies of the chemical elements. B. B. Smyth..... XIV, 100
Hay, Robert, memorial of. A. H. Thompson..... XV, 131
Hemiptera, fauna of Kansas. E. A. Popenoe..... IX, 62
Herpetology of Kansas, second contribution. F. W. Cragin..... IX, 126
History and organization of Academy. Johns D. Parker..... I, 341 (3)
—— of Academy. A. H. Thompson..... IX, 4
Horse flies of New Mexico and Arizona. C. H. T. Townsend..... XIII, 133
Hot winds, a preliminary study. T. B. Jennings..... XII, 10
Hydrometer, a new form (illustrated). G. H. Failyer..... XI, 104
Hygrometer, electrical. L. I. Blake..... XII, 67
Hymenoptera, first list of a number of families in New Mexico. T. D. A. Cockerell, XVI, 212
—— Kansas, list of. J. C. Bridwell..... XVI, 203
—— —— preliminary list. F. H. Snow..... VII, 97
Hyperchiria zephyria, preparatory stages. F. H. Snow..... IX, 61

Ibis, white-faced glossy, second occurrence in Kansas. N. S. Goss..... XII, 61
Igneous rocks of Kansas. Robert Hay..... VIII, 14
Insects, fossil, in Comanche Cretaceous of Kansas. C. N. Gould..... XVI, 284
—— injurious. S. J. Hunter..... XV, 50
—— notes (illustrated). V. L. Kellogg..... XIII, 112
—— notes on the elementary comparative external anatomy of insects. V. L. Kellogg..... XIII, 111
—— of Wallace county. F. H. Snow..... VI, 61
Internal heat of the earth. B. F. Mudge..... VI, 49
Iodoform. S. R. Boyce..... XII, 58
Iola, Kan., mineral well. W. K. Kedzie..... VI, 58
—— —— gas well. G. E. Patrick..... V, 13
Iron, on the destruction of the passivity of iron in nitric acid by magnetization (illustrated). E. L. Nichols and W. S. Franklin..... X, 13
Irrigation in Kansas. F. G. Adams..... VII, 80

Lake Doniphan, its formation in the spring and summer of 1891. E. B. Knerr... XIII, 47
Lantern, astronomical. E. B. Knerr..... XIII, 58
Larvæ, observations on the habits of certain forms. G. F. Gaumer..... IV, 22
Leather mountain, from Red Rock canon, Colorado. E. B. Knerr..... XIII, 70
Leavenworth prospect well, geology of. E. Jameson..... XI, 37

Leaves, fossil, on the discovery and significance of stipules in certain dicotyledonous leaves of the Dakota rocks (illustrated). F. H. Snow ..... XI, 33
Lepidopetera, list of, collected in Colorado, 1876. F. H. Snow ..... VI, 70
—— list of, collected near Idaho Springs, Colo., 1879. F. H. Snow..... VII, 61
—— catalogue of, in eastern Kansas, 1875. F. H. Snow..... IV, 29
—— Kansas, additions to the list. F. H. Snow..... VII, 102
—— —— collected, 1883-'84. F. H. Snow..... IX, 65
—— and Coleoptera collected in New Mexico, 1881-'82. F. H. Snow..... VIII, 35
Library, Academy, additions to, 1880..... VII, 6
—— —— catalogue to 1887. F. W. Cragin..... X, 145
—— —— report of librarian, 1887 to 1889. B. B. Smyth..... XI, 120
—— —— report to October, 1890. B. B. Smyth ..... XII, 178
—— —— report to November, 1892. B. B. Smyth..... XIII, 137
—— —— report, 1894. B. B. Smyth..... XIV, 279
—— —— report, 1897. B. B. Smyth..... XV, 137
—— —— report, 1898. B. B. Smyth..... XVI, 285
—— —— report to 1901. B. B. Smyth..... XVII, 219
Lightning freaks in 1883. Joseph Savage..... IX, 41
Lignite, Dakota, horizon of. Robert Hay..... XI, 5
Limestone and coal, chemical analyses. W. H. Saunders..... I, 392 (35)
—— Mississippian, from Atchison prospect well, analysis of. F. B. Porter..... XVII, 52
Limonite, octahedral. Erasmus Haworth..... IX, 25
Liquids, superheated, and supersaturation of vapors, experiments upon (illustrated). E. L. Nichols..... IX, 91
Loco-weed (illustrated). L. E. Sayre..... X, 65
Locust flights east of the Mississippi. C. V. Riley..... V, 62
—— Rocky Mountain. F. H. Snow..... IV, 26
Loxia curvirostra, notes on. D. E. Lantz..... XIV, 124

Magnetic declination in Kansas, October, 1880. H. S. S. Smith..... VII, 48
Mallophaga, notes on (illustrated). V. L. Kellogg..... XII, 46
Mammalia, Kansas. M. V. B. Knox ..... IV, 18; V, 64
—— of western Kansas. A. B. Baker..... XI, 56
Mammoth remains in Franklin county. O. C. Charlton..... XII, 74
Man, notes on antiquity of. A. H. Thompson..... VI, 12
Marion and Wellington formations, southern extension of. C. N. Gould..... XVII, 179
Mars, where did Mars get its moons (illustrated)? E. Miller..... XV, 46
Mastodon remains in Douglas county. J. Savage..... VI, 10
Meleagris ocellata, notes on. G. F. Gaumer..... VIII, 60
Membership, Academy list, 1889, 1901..... XVI, 13; XVII, 16
Mentor beds. A. W. Jones..... XV, 111
—— —— new developments in. A. W. Jones ..... XVI, 65
Metamorphic deposit in Woodson county. B. F. Mudge..... VII, 12
Metamorphism, the study of natural palimpsests. G. P. Grimsley..... XV, 127
Meteorite, Brenham, additional note (illustrated). Robert Hay..... XIII, 75
Meteorites, some, from Kansas. F. H. Snow..... XII, 105
—— Waconda specimen. G. H. Patrick..... V, 12
Meteorology (see, also, Climate).
Meteorological summary for 1872. F. H. Snow..... I, 196 (61)
—— —— for 1873. F. H. Snow..... II, 19 (86)
—— —— for 1874. F. H. Snow..... III, 28 (130)
—— —— for 1875. F. H. Snow..... IV, 60
—— —— for 1876. F. H. Snow..... V, 59
—— —— for 1877. F. H. Snow..... VI, 89
—— —— for 1878, 1880. F. H. Snow..... VII, 89
—— —— for 1881. F. H. Snow..... VIII, 23
—— —— for 1882. F. H. Snow..... VIII, 81
—— —— for 1883. F. H. Snow..... IX, 43
—— —— for 1884. F. H. Snow..... IX, 124
—— —— for 1885. F. H. Snow..... X, 31
—— —— for 1886. F. H. Snow..... X, 142
—— —— for 1887, 1888. F. H. Snow..... XI, 115
—— —— for 1889. F. H. Snow..... XII, 49
Meteors, observation of November meteors. [illegible] ..... IX, 103
Microscope, pocket, a new frame for. I[illegible] ..... XII, 18

Minerals found in Kansas. B. F. Mudge ..... VII, 27
—— Kansas, notes on. Erasmus Haworth ..... VIII, 25
—— —— revised list. G. H. Failyer and E. H. S. Bailey ..... XIII, 76
—— —— a new form. J. T. Willard ..... IX, 25
Mineral waters, utilization of. E. H. S. Bailey ..... IX, 28
—— —— Kansas, notes on. G. H. Failyer ..... IX, 114
—— —— —— notes on. G. H. Failyer and J. T. Willard ..... X, 63
—— —— notes. G. H. Failyer and C. M. Breese ..... XI, 109
—— —— Kansas. E. H. S. Bailey ..... XII, 25
—— —— composition in spring near Great Spirit spring, Mitchell county. E. H. S. Bailey and Mary Rice ..... XIV, 40
—— —— Kansas. H. E. Davies ..... XV, 82
—— —— Atchison and Nemaha counties. E. B. Knerr ..... XV, 88
Mineral springs and wells of Kansas. E. H. S. Bailey ..... XVI, 42
Mines and minerals of Kansas. G. P. Grimsley ..... XVII, 200
Models, mathematical (illustrated). Arnold Emch ..... XIV, 90
Momotidæ, notes on their habits. G. F. Gaumer ..... VIII, 63
Montezuma, holiday excursion to birthplace of. T. S. Case ..... VII, 13
Moon, discrepancies between theory and observation of moon's motion. F. W. Bardwell ..... III, 11 (103)
—— new theory of its surface-markings. E. Miller ..... XV, 10
Moraine, buried, of the Shunganunga (illustrated). B. B. Smyth ..... XV, 95
Mosasauroid reptile, dermal covering of (illustrated). F. H. Snow ..... VI, 54
Mosses, Kansas, and key to same (illustrated). Minnie Reed ..... XIV, 152
Moths, notes on early stages of three moths (illustrated). C. L. Marlatt ..... XI, 110
—— New Mexico, collected by F. H. Snow. A. R. Grote ..... VIII, 45
Mound-builders, civilization of. H. C. Fellow ..... XII, 90
—— —— Kansas, traces of. B. F. Mudge ..... II, 5 (69)
Mounds in Davis county. Johns D. Parker ..... X, 72
—— Kansas. F. G. Adams ..... VI, 51
—— prehistoric, in Cowley county. C. N. Gould ..... XV, 79
—— timbered, of Kaw reservation. C. N. Gould ..... XVI, 282
Mudge, B. F., memorial of. Johns D. Parker ..... VII, 7
Muscid acalyptrate, peculiar form found near Turkey Tanks, Ariz. C. H. T. Townsend ..... XIII, 135
Mustard, estimation of its volatile oil. L. E. Sayre ..... XII, 59
Mydaidæ, notes and description of. S. W. Williston ..... XV, 53

Natural gas in eastern Kansas (illustrated). Robert Hay ..... X, 57
Natural history, some notes of, 1859. J. R. Mead ..... XVI, 280
Nebraska hot bluff. W. K. Kedzie ..... IV, 10
Nervous system, recent advances in the study. C. J. Herrick ..... XIII, 70
New Zealand, its pink and white terraces. Joseph Savage ..... XI, 26
Nickel mines in Logan county. F. H. Snow ..... XI, 39
Niobrara Cretaceous of western Kansas (illustrated). S. W. Williston ..... XIII, 107
Nitrates in well-waters. E. H. S. Bailey ..... XVI, 40
Nitrogen content of maize, its variations, and possibilities for improvement. J. T. Willard ..... XVI, 46
Noctuidæ, new western forms. A. R. Grote ..... VII, 63
Norton county, preliminary report on geology of (illustrated). R. J. Brown ..... IX, 17
Number, suggestions on the true theory of. F. W. Bardwell ..... III, 4 (94)
Nutation of sunflower, observations. W. A. Kellerman ..... XII, 140

Oil, composition of a natural oil from Wilson county. F. B. Dains ..... XIV, 38
Ornithology, Kansas, review of. D. E. Lantz ..... XVI, 224
—— of Riley county. C. P. Blachly ..... VII, 105
Oxygen and its effects upon animal life. T. H. Dinsmore, jr. ..... X, 72
—— its effect upon animal life. J. T. Willard and A. T. Kinsley ..... XVII, 38
Ozone in Kansas atmosphere. W. K. Kedzie ..... IV, 4
—— in Kansas atmosphere (illustrated). W. K. Kedzie ..... VI, 18

Parasitism in Aphyllon uniflorum. J. M. Price, jr. ..... XIV, 132
Pasteur filter, some experimental tests of. L. E. Sayre ..... XII, 122
Pelecanus erythrorhynchos, feeding habits of. N. S. Goss ..... XI, 11
Peppers, commercial, quality of. L. E. Sayre ..... XI, 51

Permian fauna of central United States (illustrated). J. W. Beede..... XVII, 185
—— notice of some vertebrate remains from Kansas Permian. S. W. Williston.... XV, 120
Peronosporaceæ, list of Kansas species. W. T. Swingle..... XI, 63
—— Kansas, first addition to list. W. T. Swingle..... XII, 129
Phalarope, Wilson's, the adult male, plumage of. S. W. Williston..... VI, 39
Pheasant, how it drums. J. R. Mead ..... XIV, 113
Physiography, Kansas (illustrated). J. W. Beede..... XV, 114
—— of southeastern Kansas (illustrated). G. I. Adams..... XVI, 53
Phosphorescence of chlorophane from Pike's Peak. G. H. Failyer..... IX, 104
Plains, Great, geology and topography. Robert Hay..... XIII, 3
Plants (see, also, Botany).
—— Florida, list in my herbarium. A. S. Hitchcock..... XVI, 108; XVII, 79
—— fossil, in Kansas Permian. E. H. Sellards..... XVII, 208
—— Kansas, catalogue of plants. J. H. Carruth..... I, 346 (8)
—— —— centennial catalogue of. J. H. Carruth..... V, 40
—— —— native, adapted to cultivation. Grace R. Meeker..... XVII, 105
—— —— additions to list. B. B. Smyth..... XIV, 133
—— list of, collected by Garfield University, 1889. M. A. Carleton..... XIII, 50
—— periodicity in, and floral clock. B. B. Smyth ..... XII, 75
—— found in Cherokee county, Texas. Mrs. A. L. Slosson..... XII, 62
Pleistocene of Kansas. S. W. Williston ..... XV, 90
Plesiosaurs, interesting food habits (illustrated). S. W. Williston..... XIII, 121
—— new form from Niobrara Cretaceous of Kansas (illustrated). S. W. Williston, XII, 174
Pliocene Tertiary of western Kansas. B. F. Mudge..... III, 17 (113)
Polyphilla variolosa, observations on use of the antennæ. F. H. Snow..... III, 27 (128)
Poor-will, frosted, notes on. D. E. Lantz..... XV, 14
Porcellio, preliminary note on the origin and maturation of the ovum. F. W. Cragin, IX, 140
Prairie-dogs, habits of. H. A. Brous ..... V, 10
Precipitation, annual, of rain and snow at Manhattan for the past thirty-two years (illustrated). C. M. Breese ..... XII, 166
Prehistoric people, camps of, in Sedgwick county. J. R. Mead..... XII, 64
Preservative fluids for museum use, comparison. V. L. Kellogg and E. E. Slosson, XII, 83
Proceedings of the Academy, first five meetings, 1868-1872..... I, 344 (6)
—— —— —— sixth meeting, 1873 ..... II, 3 (67)
—— —— —— seventh meeting, 1874..... III, 3 (93)
—— —— —— eighth meeting, 1875 ..... IV, 3
—— —— —— ninth meeting, 1876..... V, 3
—— —— —— tenth and eleventh meetings, 1877, 1878..... VI, 3
—— —— —— twelfth and thirteenth meetings, 1879, 1880 ..... VII, 3
—— —— —— fourteenth meeting, 1881..... VIII, 3
—— —— —— fifteenth to twenty-second meetings (see reports IX, X, XI, XII).
—— —— —— twenty-third meeting, 1890..... XII, 57
—— —— —— twenty-fourth to thirty-third meetings, 1891 to 1900 (see reports XIII to XVII).
Protozoan remains in Kansas chalk (illustrated). G. E. Patrick..... VIII, 26
Pueblo ruins in New Mexico, explorations (illustrated). J. R. Mead..... X, 73

Quails, were they native to Kansas? J. R. Mead..... XVI, 277
Quintard, J. B., memorial of (illustrated)..... XVII, 217

Radiation of heat from foliage. A. G. Mayer..... XII, 61
Rainfall in its relation to Kansas farming. H. R. Hilton..... VII, 39
—— in Kansas, is it increasing (illustrated)? E. C. Murphy ..... XIII, 16
—— —— is it increasing? F. H. Snow..... IX, 101
—— —— seven-year periodicity. E. C. Murphy ..... XIII, 60
Rain-waters, ammonia and nitric acid in. G. H. Failyer ..... XII, 21
—— the occurrence of nitrites in. G. H. Failyer..... XI, 24
Rattlesnake, on the bite of. Joseph Savage ..... VI, 36
Reagent bottle, inexpensive, for use in microscopic work (illustrated). E. B. Knerr. ..... XIII, 23
Relativity in science. E. B. Knerr..... XVI, 34
Reptiles and batrachians, Kansas, preliminary list. F. W. Cragin..... VII, 114
River counties of Kansas, geology and mineral resources. Robert Hay..... XIV, 230
Root tubercles and their production by inoculation (illustrated) Otis.. XVI, 88

Rosinweed, an examination of its resinous exudation. L. E. Sayre..... XI, 103
Rot, black, of the grape. C. R. Carpenter..... XI, 14
Rotation periods of Mercury, Venus, and the satellites of the solar system. E. Miller..... XIV, 94

Saccharine substances in the stem of Sorghum vulgare. G. H. Failyer..... IX, 34
Salamander, common, mode of respiration (illustrated). F. H. Snow..... XII, 31
Salt, analysis of. G. E. Patrick..... IV, 16
Salt beds in Ellsworth county. Robert Hay..... XI, 8
Salt marshes, Kansas, notes on (illustrated). Robert Hay..... XII, 97
Salt plains of Oklahoma. C. N. Gould..... XVII, 181
Sand-dune collecting. Warren Knaus..... XIV, 126
Sandstone, red, of central Kansas. B. F. Mudge..... I, 394 (37)
Sap, notes on circulation. W. R. Lighton..... XI, 18
Savage, Joseph, memorial of. Robert Hay..... XIII, 65
Saw-fly, red cedar, notes on (illustrated). C. L. Marlatt..... X, 80
Science in education. S. W. Williston..... XVI, 16
—— in the public schools. D. S. Kelly..... XV, 42
Serpent, sonoran, from Kansas (new variety). F. W. Cragin..... X, 85
Shawnee county stratigraphy. J. W. Beede..... XV, 27
Silica cement mortars. W. Tweedale..... XVII, 42
Silico-barite nodules from near Salina (illustrated). E. B. Knerr..... XVI, 43
Sink holes in Wabaunsee county. Joseph Savage..... VII, 26
Siphoning extraction apparatus, glass (illustrated). J. T. Willard and G. H. Failyer..... XII, 165
Sky, the (illustrated). E. L. Nichols..... X, 111
Small things. E. H. S. Bailey..... XIV, 6
Smell sensations, classification. W. S. Franklin..... XII, 7
—— Some special tests in regard to delicacy of sense of smell. E. H. S. Bailey and L. M. Powell..... IX, 100
Smut, sorghum, notes on (illustrated). W. A. Kellerman and W. T. Swingle..... XII, 158
Snakes, Kansas, list of, in museum State University. Annie E. Mozley..... VI, 34
Soils, Kansas, analysis of. G. E. Patrick..... IV, 15
Soils, composition, effect upon, of continuous cropping by wheat. J. T. Willard..... XVII, 41
Solanum rostratum, examination of. W. S. Amos and L. E. Sayre..... XIII, 21
Solar attachment to the engineer's transit, note on precision of. F. O. Marvin, XII, 164
Solubilities, on determining the solubilities of metallic salts (illustrated). G. E. Patrick and A. B. Aubert..... III, 19 (117)
Sorghum, improvement of, by seed selection. G. H. Failyer and J. T. Willard.. XIII, 69
Sound transmission by electricity. J. T. Lovewell..... VI, 25
Spanish Peaks, notes on geology of. Joseph Savage..... IX, 113
Spectra absorption, new method of studying (illustrated). W. S. Franklin..... IX, 98
Spermophilus Richardsonii. S. W. Williston..... VI, 39
Sphinx, sage, larva and chrysalis of. F. H. Snow..... IV, 28
Standard time. H. S. S. Smith..... VIII, 30
Stone, building, composition of some. E. H. S. Bailey and E. C. Case..... XIII, 78
Stone implements in Trego county. Joseph Savage..... VII, 60
Sugar content, variation in, of Sorghum vulgare. J. T. Willard..... X, 70
Sugar crystals, observation of their formation in the juice of Sorghum saccharatum. E. B. Cowgill..... X, 26
Sugar, invert, its sweetness and notes on its preparation. J. T. Willard..... X, 24
Sugar, ultramarine blue in. H. L. Raymond..... XI, 25
—— of watermelons. J. T. Willard..... XII, 95
Sun, corona of (illustrated). E. Miller..... XVII, 210

Tabanidæ, North American, notes and descriptions. S. W. Williston..... X, 129
Taraxacum dens-leonis, as illustration of variable chemical composition of plants at different seasons. L. E. Sayre..... XIII, 106
—— root, experiments on. L. E. Sayre..... XIV, 42
Taste, selective power of the sense of. E. H. S. Bailey..... XII, 101
—— some experiments on the relation between the taste and the acidity of certain acids. E. H. S. Bailey..... XI, 10
Tea, is the alkaloidal strength of tea an index of its commercial value? L. E. Sayre..... XI, 50

Tea, analysis, notes on. H. R. Bull ..... IX, 42
Temperatures, daily curve of mean temperatures at Lawrence for twenty-one years, 1868 to 1888 (illustrated). F. H. Snow ..... XII, 52
—— mean monthly, equation of the curve of twenty-one years at Lawrence (illustrated). E. C. Murphy ..... XII, 160
—— probable, of the summer in Lawrence. E. C. Murphy ..... XIII, 58
Therapeutical notes and descriptions of parts of medicinal plants growing in Kansas. L. E. Sayre ..... XVI, 85
—— value of some recently introduced chemicals. L. E. Sayre ..... XIII, 28
Tin salting enterprises in the United States. W. F. Kedzie ..... III, 13 (106)
Topeka coal hole (illustrated). B. B. Smyth ..... XIV, 207
Treehopper, buffalo, notes on the oviposition of. C. L. Marlatt ..... X, 84
Triassic rocks of Kansas. Robert Hay ..... XI, 38
Turtle, fossil cast from the Dakota (illustrated). C. S. Parmenter ..... XVI, 67
—— new, from Kansas Cretaceous (illustrated). S. W. Williston ..... XVII, 195
Tusk, fossil, found in Franklin county. Wm. Wheeler ..... VI, 11
Tweeddale, Wm., memorial of (illustrated) ..... XVII, 218

Unionidæ, list of, collected in Kansas rivers. E. A. Popenoe ..... IX, 78
Uredineæ, Kansas. Elam Bartholomew ..... XVI, 168

Variations in dominant species of plants. M. A. Carleton ..... XIII, 24; XIV, 45
Vegetation, condensed notes on, in western Kansas. Minnie Reed ..... XIII, 91
Vireo, yellow-throated, notes on its nesting habits. N. S. Goss ..... IX, 33
Vitis, distribution of the genus in Kansas. A. S. Hitchcock ..... XIII, 79

Waconda (see Great Spirit spring).
Water, magnesian, near Madison, Kan., analysis. F. W. Bushong ..... XVII, 53
—— purification (illustrated). Wm. Tweedale ..... XVI, 48
—— supply from a sanitary standpoint. F. O. Marvin ..... XVII, 54
—— —— new, of University of Kansas. E. C. Murphy ..... XIV, 98
Weather service, Kansas. J. T. Lovewell ..... VII, 86
Well, breathing, in Logan county. J. T. Willard ..... XIII, 73
—— deep, at Madison, Kan. (illustrated). F. W. Bushong ..... XVI, 67
West, E. P., memorial of. S. W. Williston ..... XIII, 63
Wheat, who sold his wheat for $1.40? an examination of the value of Blake's tables. G. E. Curtis ..... XII, 37
Wichita drill hole. J. R. Mead ..... XV, 20
Wilson county, geological section in (illustrated). Robert Hay ..... X, 6
Wind effects on plants, bibliography of. J. B. S. Norton ..... XVI, 103
—— new method of determining its velocity. J. H. Long ..... VI, 87
—— velocity at Manhattan (illustrated). C. M. Breese ..... XII, 167
Women, some statistics relating to the health of college women. Gertrude Crotty ..... XIII, 33
Wood-borer, note on the oviposition of. E. A. Popenoe ..... XII, 15

GENERAL INDEX TO AUTHORS.

Adams, F. G. Irrigation in Kansas ..... VII, 80
—— Kansas mounds ..... VI, 51
Adams, Geo. I. Physiography of southeastern Kansas ..... XVI, 53
Amos, W. S., and L. E. Sayre. Examination of Solanum rostratum ..... XIII, 21

Bailey, E. H. S. (See G. H. Failyer for joint paper.)
—— Chemical composition of cement plaster ..... XVI, 38
—— Chemical composition of some culinary utensils ..... IX, 29
—— and E. C. Case. Chemical composition of some Kansas building stone ... XIII, 78
—— Chemical composition of Kansas coals ..... XI, 46
—— and Mary A. Rice. Composition of water from a mineral spring in Mitchell county ..... XIV, 40
—— Experiments on relative heating gas ..... XVII, 35
—— Feather alum from Colorado ..... XII, 101

Bailey, E. H. S., and B. B. Smyth. Memorial of J. H. Carruth..... XV, 135
—— and E. E. Slosson. Minerals, barite and others, in the concretionary rocks of eastern Kansas..... XII, 45
—— Miscellaneous chemical notes..... X, 62
—— On the economical value of corn-cobs..... XI, 49
—— On the newly discovered salt beds in Ellsworth county..... XI, 8
—— On the occurrence of bromides and iodides in the water of an artesian well at Independence..... X, 22
—— On the occurrence of nitrates in well-water..... XVI, 40
—— Organic and physiological chemistry..... IX, 87
—— Report on the mineral springs and wells of Kansas..... XVI, 42
—— Selective power of the sense of taste..... XII, 101
—— Small things..... XIV, 6
—— Some experiments on the relation between the taste and the acidity of certain acids..... XI, 10
—— Some Kansas mineral waters..... XII, 25
—— and E. C. Franklin. The relative bitterness of different bitter substances... X, 23
—— Some special tests in regard to the delicacy of the sense of smell..... IX, 100
—— The water of the Fort Scott artesian well..... IX, 96
—— The utilization of mineral waters..... IX, 28
Baker, A. B. Mammals of western Kansas..... XI, 56
Bardwell, F. W. Discrepancies between theory and observation of the moon's motion..... III, 11 (103)
—— Speculations in regard to comets' tails..... II, 14 (79)
Bartholomew, Elam. Kansas Uredineæ..... XVI, 168
Beede, J. W. Fauna of the Permian of the central United States, part I..... XVII, 185
—— On the correlation of the Coal Measures of Kansas and Nebraska..... XVI, 70
—— Notes on Kansas physiography..... XV, 114
—— The McPherson Equus beds..... XV, 104
—— The stratigraphy of Shawnee county..... XV, 27
Bidwell, W. D. The human eye, the changes which occur in middle life..... XI, 101
Blachly, C. P. Ornithology of Riley county..... VII, 105
Blake, L. I., and W. S. Franklin. In regard to color-blindness among Indians.... XI, 105
—— The evaporative power of Kansas coals..... XI, 42
—— An electrical hygrometer..... XII, 67
—— and H. Radcliffe. The insulation resistance of some electric-light wires... XII, 44
Boyce, S. R. Iodoform..... XII, 58
Breese, C. M. (See G. H. Failyer for joint paper.)
—— Annual precipitation of rain and snow at Manhattan for the past thirty-two years..... XII, 166
—— Statistics on color-blindness among the students at the State Agricultural College..... XI, 106
—— Wind velocity at Manhattan..... XII, 167
Bridwell, J. C. List of Kansas Hymenoptera..... XVI, 203
Brous, H. A. Habits of Amblychila cylindriformis..... V, 11
—— Habits of prairie-dogs..... V, 10
Brown, R. J. Is a geological survey of the state a necessity?..... IX, 49
—— Preliminary report on the geology of Norton county..... IX, 17
Bull, H. R. Notes on tea analysis..... IX, 42
Bushong, F. W. Analysis of magnesia water found near Madison, Kan..... XVII, 53
—— Deep well at Madison..... XVI, 67
—— On the alkyl hypobromites..... XV, 81

Carleton, M. A. Characteristic sand-hill flora..... XII, 32
—— List of plants collected by Garfield University expedition of 1889..... XIII, 50
—— New Æcidium of peculiar habit..... XIV, 44
—— Variations in dominant species of plants..... XIII, 24; XIV, 45
—— (See W. A. Kellerman for joint paper.)
Carpenter, C. R. The black rot of the grape..... XI, 14
Carruth, J. H. Catalogue of plants seen in Kansas..... I, 346 (8)
—— Report on botany of Kansas for 1873..... II, 9 (74)
—— Report on botany of Kansas for 1874..... III, 23 (122)
—— Centennial catalogue of Kansas plants..... V, 40
—— Botanical addenda..... VI, 40
—— Botanical addenda for 1879 and 1880..... VII, 123

Carruth, J. H. Botanical addenda for 1881 and 1882..... VIII, 32
—— Botanical addenda for 1883 and 1884..... IX, 142
—— Botanical notes for 1889..... XII, 43
Case, E. C. Analysis of the deposit from a chalybeate water..... XIV, 36
Case, T. S. A holiday excursion to the birthplace of Montezuma..... VII, 13
Castle, W. E. List of flowering plants and ferns in Franklin county..... XIII, 80
Charles, H. W. Dakota sandstone in Washington county..... XVII, 194
Charlton, O. C. On the occurrence of mammoth remains in Franklin county..... XII, 74
—— Preliminary observations of the destructive burrowing of shale..... XII, 75
Chase, G. S. Archæological notes..... IX, 30
Cockerell, T. D. A. A first list of several Hymenopterous families in New Mexico, XVI, 212
Collette, A. M. Nesting of the pied-billed grebe..... XIII, 49
—— Two rare birds of Kansas..... XIII, 29
Cowgill, E. B. Observation of the formation of sugar crystals in the juice of Sorghum saccharatum..... X, 26
Cragin, F. W. Preliminary catalogue of Kansas reptiles and batrachians..... VII, 114
—— Contribution to the history of the fresh-water Copepoda..... VIII, 66
—— Preliminary note on the origin and maturation of the ovum in Porcellio.... IX, 140
—— Second contribution to the herpetology of Kansas, with observations on the Kansas fauna..... IX, 136
—— Note on a new variety of a sonoran serpent from Kansas..... X, 85
Crotty, Gertrude. Methods of collecting, cleaning and mounting diatoms..... XII, 81
—— Some statistics relating to the health of college women..... XIII, 33
Curtis, G. E. Who sold wheat for $1.40? an examination of the value of Blake's tables..... XII, 37
Curtis, G. H. Diatomaceæ of Reno county..... XVII, 70
—— Some Diatomaceæ of Kansas..... XVII, 67
—— The food of fish in central Kansas..... XVII, 75

Dains, F. B. Composition of a natural oil from Wilson county..... XIV, 38
Dalton, B. J., and F. O. Marvin. Note on the second setting of cement..... XII, 10
Davies, H. E. Kansas mineral water..... XV, 82
Dinsmore, T. H. An improved fire screen..... XII, 81
—— Preliminary report concerning the effect of oxygen upon animal life..... X, 72
Dyche, L. L. Notes on three species of gophers found at Lawrence..... XII, 29

Edwards, W. H. Description of a new species of Chrysophanus..... VII, 69
Emch, Arnold. Mathematical models..... XIV, 90

Failyer, G. H. (See J. T. Willard for joint papers.)
—— Ammonia and nitric acid in rain-water collected at Agricultural College... XII, 21
—— and C. M. Breese. Mineral waters..... XI, 109
—— A new form of hydrometer..... XI, 104
—— Notes on some Kansas mineral waters..... IX, 114
—— On the distribution of saccharine substances in the stem of Sorghum vulgare..... IX, 34
—— On the phosphorescence of chlorophane from Pike's Peak..... IX, 104
—— and J. T. Willard. On the improvement of sorghum by seed selection.... XIII, 69
—— On the occurrence of nitrites in rain-water..... XI, 24
—— and J. T. Willard. On some Kansas mineral waters..... X, 63
—— and E. H. S. Bailey. Revised list of Kansas minerals..... XIII, 76
—— Traces of the aborigines in Riley county..... VII, 132
Fee, John. Color-blindness and railway accidents..... VII, 30
Fellow H. C. The civilization of the mound-builders..... XII, 90
Franklin, W. S. (See L. I. Blake for joint paper.)
—— (See E. L. Nichols for joint paper.)
—— A new method of studying absorption spectra..... IX, 98
—— On the classification of the sensations of smell..... XII, 7

Gaumer, G. F. Notes on the habits of certain Momotidæ..... VIII, 63
—— Notes on Meleagris ocellata..... VIII, 60
—— Observations on the habits of certain larvæ..... IV, 22
Goss, N. S. Additions to catalogue of birds of Kansas.... X, 29; XI, 60; XII, 24
—— Birds new to the fauna of Kansas and birds rare in ..... IX, 26

Goss, N. S. Feeding habits of Pelecanus erythrorhynchos ..... XI, 11
—— Ictinia mississippiensis and Ægialitis nivosa, nesting in south-central Kansas ..... XI, 11
—— Notes on the yellow-tailed cassique ..... XI, 12
—— Observations of the breeding habits of the American eared grebes..... IX, 31
—— Observations of the nesting habits of the guillemots at Bird Rock..... VIII, 59
—— Observations of the nesting habits of the yellow-throated vireo..... IX, 33
—— Second occurrence of white-faced glossy ibis in Kansas ..... XII, 61
—— The anhinga ..... XI, 58
—— The double-crested cormorant..... XI, 59
Gould, C. N. Additional notes on the timbered mounds of the Kaw reservation, XVI, 282
—— Dakota Cretaceous of Kansas and Nebraska ..... XVII, 122
—— Natural history possibilities of Belvidere, Kan., and vicinity ..... XVI, 283
—— On the finding of fossil insects in the Comanche Cretaceous of Kansas..... XVI, 284
—— On the southern extensions of the Marion and Wellington formations.... XVII, 179
—— Prehistoric mounds in Cowley county..... XV, 79
—— Salt plains of Oklahoma..... XVII, 181
—— The timbered mounds of the Kaw reservation..... XV, 78
Graham, I. D. Preliminary list of Kansas fishes..... IX, 69
Grimsley, G. P. Gypsum in Kansas..... XV, 122
—— Kansas mines and minerals..... XVII, 200
—— The study of natural palimpsests..... XV, 127
Grote, A. R. New Western Noctuidæ..... VII, 63
—— On the moths collected by F. H. Snow in New Mexico..... VIII, 45

Hanly, H. J. Cone in cone (an impure calcite)..... XV, 22
—— Provisional list of flowering plants of McPherson county..... XV, 75
Harris, J. A. Annotated catalogue of the crayfishes of Kansas ..... XVII, 115
Haworth, Erasmus. Are there igneous rocks in Cherokee county?..... VIII, 18
—— The coal-fields of Cherokee county..... VIII, 7
—— Notes on Kansas minerals..... VIII, 25
—— Octahedral limonite..... IX, 25
Hay, Robert. Artesian wells in Kansas and the causes of their flow..... XII, 24
—— A geological section in Wilson county..... X, 6
—— Additional note on the Brenham meteorite ..... XIII, 75
—— Bibliography of Kansas geology..... XIV, 261
—— Fossil wood..... VIII, 20
—— Geology of Kansas..... XI, 35
—— And A. H. Thompson. Historical sketch of the geological work in the state of Kansas. ..... X, 45
—— Horizon of the Dakota lignite..... XI, 5
—— Igneous rocks of Kansas..... VIII, 14
—— In the Dakota..... IX, 109
—— Memorial of Joseph Savage..... XIII, 65
—— Natural gas in eastern Kansas ..... X, 57
—— Note on a habit of red ants..... X, 27
—— Note on a remarkable fossil..... X, 128
—— Notes on some Kansas salt marshes..... XII, 97
—— Notes on some new species of fossil cephalopods..... XIII, 37
—— Notes on occurrence of granite in a deep boring in eastern Kansas ..... XIII, 75
—— Notes on the fossil jaw of bison from the Pliocene of Norton county..... IX, 98
—— On eastern extension of Cretaceous rocks in Kansas and the formation of certain sand-hills..... XIV, 227
—— Report on geology..... X, 21
—— River counties of Kansas..... XIV, 230
—— Some characteristics of the glaciated area of northeastern Kansas ..... XIII, 104
—— The great plains ..... XIII, 3
—— Triassic rocks of Kansas ..... XI, 38
Herrick, C. J. Recent advances in the study of the nervous system..... XIII, 70
Hilton, H. R. Rainfall in its relations to Kansas farming..... VII, 39
Hinckley, H. V. Atlantic vs. Pacific elevations in Kansas..... X, 53
Hitchcock, A. S. A brief outline of ecology..... XVII, 28
—— Distribution of the genus Vitis in Kansas..... XIII, 79
—— List of plants in my Florida herbarium..... XVI, 108; XVII, 79
—— Relations of the composite flora of Kansas..... XIII, 89

Hitchcock, A. S. The grasses of Kansas ..... XIV, 126
—— Additions to the grasses of Kansas ..... XV, 59
Horn, G. H. (See J. L. Le Conte for joint paper.)
Hovey, H. C. Brachiospongia ..... III, 10 (111)
Hunter, S. J. Notes on the corn-root worm ..... XIII, 131
—— Notes on injurious insects ..... XV, 50

Jameson, E. Geology of the Leavenworth prospect well ..... XI, 37
Jennings, T. B. A preliminary study of hot winds ..... XII, 10
Jewell, Mrs. E. C. List of some of larger fungi found in the Blue river valley .... VII, 131
Jones, A. W. The Mentor beds ..... XV, 111
—— New developments in the Mentor beds ..... XVI, 65

Kedzie, W. K. On tin salting enterprises in the United States ..... III, 13 (106)
—— Ozone in Kansas atmosphere ..... IV, 4; VI, 18
—— The Iola mineral well ..... VI, 58
—— The Nebraska hot bluff ..... IV, 10
Kellerman, Mrs. W. A. Evolution in leaves ..... XII, 168
Kellerman, W. A. An artificial key to the Kansas grasses ..... XI, 87
—— A partial list of the Kansas parasitic fungi, together with their host-plants (illustrated) ..... IX, 79; X, 88
—— Note on the distribution and ravages of the hackberry branch knot ..... XII, 101
—— On the germination of Indian corn after immersion in hot water ..... XII, 134
—— and W. T. Swingle. Notes on sorghum smuts ..... XII, 158
—— Observations on the nutation of sunflowers ..... XII, 140
—— The Kansas forest-trees identified by leaves and fruit ..... X, 99
Kellogg, V. L. Additions to Goss's revised catalogue of the birds of Kansas ..... XV, 15
—— and E. E. Slosson. Comparison of preservative fluids for museum use ..... XII, 83
—— Insect notes ..... XIII, 112
—— Notes on elementary comparative external anatomy of insects ..... XIII, 111
—— Notes on some summer birds of Estes Park, Colo ..... XII, 86
—— Some notes on the Mallophaga ..... XII, 46
Kelly, D. S. Coal Measures of Lyon county ..... X, 45
—— Science in the public schools ..... XV, 42
Kilian, E. A. Observations on the divining rod ..... XI, 114
Kimball, Bertha S. Habits and life-history of Conorhinus sanguisugus ..... XIV, 128
Kinsley, A. T. (See J. T. Willard for joint paper.)
Knaus, Warren. Additions to catalogue of Kansas Coleoptera for 1883, 1884 ..... IX, 57
—— Additions to list of Coleoptera for 1885, 1886 ..... X, 86
—— Additions to list of Coleoptera, 1896 ..... XV, 18
—— Additions to list of Coleoptera, 1899, 1900 ..... XVII, 109
—— Collecting notes on Kansas Coleoptera ..... XVI, 197
—— On some salt-marsh Coleoptera ..... IX, 64
—— Sand-dune collecting ..... XIV, 126
Knerr, E. B. All energy is kinetic ..... XIII, 30
—— An astronomical lantern ..... XIII, 58
—— An inexpensive reagent bottle for use in microscopic work ..... XIII, 23
—— Atchison and Nemaha county mineral water ..... XV, 88
—— Barite nodules in wood ..... XV, 80
—— Coal in Atchison county ..... XIV, 216
—— Concretions ..... XVI, 44
—— Erythronium mesochoreum ..... XIII, 20
—— Notes on mountain leather from Red Rock canon, Colorado ..... XIII, 70
—— Notes on a pink barite from Atchison limestone ..... XIII, 76
—— Relativity in science ..... XVI, 34
—— Silico-barite nodules from Salina, Kan ..... XVI, 43
—— The formation of Doniphan lake in 1891 ..... XIII, 47
—— The Muscotah artesian wells ..... XVII, 53
—— Theory of the cosmos ..... XVII, 20
—— The propagation of erythroniums ..... XV, 73
—— Variety of Ampelopsis quinquefolia ..... XIII, 69
Knox, M. V. B. Calamites ..... IV, 17
—— Climate and brains 5
—— Kansas mammalia .....
—— Additions to Kansas mammalia .....

Langworthy, A. E. The Atchison diamond-drill prospect hole..... XVII, 45
Lantz, D. E. Annotated list of the birds found near Manhattan..... XIV, 115
—— List of birds collected by Col. N. S. Goss in Mexico and Central America.. XVI, 218
—— List of birds seen in Dickinson county, 1898 to 1900..... XVII, 116
—— Notes on the frosted poor-will..... XV, 14
—— Notes on Loxia curvirostra..... XIV, 124
—— Review of Kansas ornithology..... XVI, 224
—— The Kansas Academy of Science..... XVI, 24
Le Conte, J. L., and G. H. Horn. Description of new species of North America Coleoptera..... VII, 74
Lighton, W. R. Notes on circulation of sap..... XI, 18
Long, J. H. A new method of determining the wind's velocity..... VI, 87
Lovewell, J. T. Kansas weather service..... VII, 86
—— On sound transmission by electricity..... VI, 25

Marlatt, C. L. Notes on the early stages of three moths..... XI, 110
—— Notes on the oviposition of the buffalo treehopper..... X, 84
—— Notes on the red cedar saw-fly..... X, 80
Marvin, F. O. (See B. J. Dalton for joint paper.)
—— Notes on magnetic declination in Kansas..... XII, 8
—— Note on the precision of the solar attachment to the engineer's transit..... XII, 164
—— Water-supply from a sanitary standpoint..... XVII, 54
Mason, S. C. A preliminary list of fossils found in Riley county..... VIII, 12
Matthews, R. Antrostomus carolinensis..... XVI, 277
—— The black duck in Kansas..... XVII, 114
Mayer, A. G. Radiation of heat from foliage..... XII, 61
—— Selective absorption of heat by leaves..... XIII, 48
Mead, J. R. Archæology of Catalina island..... XVII, 215
—— A dying river (Arkansas)..... XIV, 111
—— Camps of prehistoric people in Sedgwick county..... XII, 64
—— Felis concolor..... XVI, 278
—— Flint Hills of Kansas..... XVII, 207
—— How the pheasant drums..... XIV, 113
—— Notes on the occurrence of gold in Montana..... XII, 5
—— Results of some explorations among the Pueblo ruins in New Mexico..... X, 73
—— Some natural-history notes of 1859..... XVI, 280
—— Some notes on the birds of southern Kansas..... XVI, 216
—— The drill-hole at Wichita..... XV, 20
—— Were quails native to Kansas?..... XVI, 277
Meeker, Grace R. Native plants of Kansas adapted to cultivation..... XVII, 105
Merrill, C. D. Notes on Giants' Causeway and Fingal's Cave..... VI, 6
Miller, E. A new theory of the surface-markings of the moon..... XV, 10
—— Differentials of the second and higher orders..... XII, 65
—— The corona of the sun..... XVII, 210
—— The periods of rotation of Mercury and Venus and the satellites of the solar system..... XIV, 94
—— Where did Mars get its moons?..... XV, 46
Mozley, Annie E. List of Kansas snakes in the museum of the Kansas State University..... VI, 34
Mudge, B. F. A geological survey of Kansas..... III, 8 (101)
—— Annual report of committee on geology, 1876..... V, 4
—— Bison latifrons in Kansas..... V, 9
—— Cretaceous forests and their migrations..... VI, 46
—— Geology of the Arkansas..... I, 408 (50)
—— Internal heat of the earth..... VI, 49
—— List of minerals found in Kansas..... VII, 27
—— Metamorphic deposit in Woodson county..... VII, 12
—— Pliocene Tertiary in western Kansas..... III, 17 (113)
—— Rare forms of fish in Kansas..... III, 22 (121)
—— Recent discoveries of fossil footprints in Kansas..... II, 7 (71)
—— Red sandstone of central Kansas..... I, 394 (37)
—— Traces of mound-builders in Kansas..... II, 5 (69)
Murphy, E. C. Equation of the mean monthly twenty-one-year temperature curve of Lawrence..... XII, 160
—— Is the rainfall of Kansas increasing?..... XIII, 16

Murphy, E. C. Maximum bending moments for moving loads in a draw-beam.. XIII, 116
—— New water-supply of the University of Kansas..... XIV, 98
—— Probable temperature of the summer in Lawrence..... XIII, 58
—— Seven-year periodicity in rainfall..... XIII, 60
—— Some tests of cements manufactured in Kansas..... XII, 12

Newson, H. B. Imaginary focal properties of conics..... XII, 84
Nichols, E. L. A class-room experiment on ebullition..... IX, 27
—— Experiments upon superheated liquids and upon supersaturation of vapors, IX, 91
—— On black and white..... X, 87
—— and W. S. Franklin. On the destruction of the passivity of iron in nitric acid by magnetization..... X, 13
—— Statistics on color-blindness in the University of Kansas..... IX, 95
—— The sky..... X, 111
Norton, J. B. S. Bibliography of literature relating to the effects of wind on plants..... XVI, 103

Osburn, W. The cottonwood leaf beetle..... IV, 24
Otis, D. H. Root tubercles and their production by inoculation..... XVI, 88

Parker, Johns D. Memorial of B. F. Mudge..... VII, 7
—— Mounds in Davis county..... X, 72
—— The river bluffs..... V, 71
Parmenter, C. S. Fossil turtle cast from the Dakota..... XVI, 67
Parrott, P. J. The elm-tree girdler..... XVI, 200
Patrick, G. E. Analysis of Kansas soils..... IV, 15
—— Analyses of salt..... IV, 16
—— Kansas chalk..... IV, 13
—— and A. B. Aubert. On determining the solubilities of metallic salts..... III, 19 (117)
—— Protozoan remains in Kansas chalk..... VIII, 26
—— The Great Spirit spring..... VII, 22
—— The Waconda meteorite..... V, 12
—— The Iola gas well..... V, 13
Plank, E. N. Preliminary notice of the flora of Montgomery county..... VIII, 33
Popenoe, E. A. A list of Kansas Coleoptera, 1876..... V, 21
—— Additions to catalogue of Coleoptera..... VI, 77
—— Contributions to a knowledge of Hemiptera fauna of Kansas..... IX, 62
—— List of Unionidæ collected in Kansas rivers, with localities..... IX, 78
—— Note on the oviposition of a wood-borer..... XII, 15
Porter, F. B. Analyses of the Mississippian limestone from Atchison prospect well..... XVII, 52
Powell, L. M., and E. H. S. Bailey. Some special tests in regard to the delicacy of the sense of smell..... IX, 100
Price, J. M., jr. Parasitism in Aphyllon uniflorum..... XIV, 132
—— Rock exposures about Atchison..... XIV, 218

Radcliffe, H. (See L. I. Blake for joint paper.)
Raymond, H. L. Ultramarine blue in sugars..... XI, 25
Reed, Minnie. Ferns of Wyandotte county..... XIV, 150
—— Kansas mosses..... XIV, 152
—— Long-continued blooming of Malvastrum coccineum..... XIV, 132
—— Some notes on condensed vegetation in western Kansas..... XIII, 91
Rice, Mary A. (See E. H. S. Bailey for joint paper.)
Rice, M. E. The inverse of conics and conicoids from the center..... XIV, 14
Riley, C. V. Locust flights east of the Mississippi..... V, 62

Sadler, H. E. Coal-oil legislation..... IX, 36
—— On the testing of burning fluids..... IX, 39
Saunders, W. H. Analysis of clays..... III, 7 (99)
—— Coals of Kansas..... I, 387 (30)
—— Limestones and coal..... I, 392 (35)
Savage, Joseph, Christening Amethyst mountain..... IX, 105
—— Notes on the geology of the Spanish Peaks..... IX, 113
—— On the bite of the rattlesnake..... VI, 36

Savage, Joseph. On mastodon remains in Douglas county..... VI, 10
—— Sink holes in Wabaunsee county..... VII, 26
—— Some lightning freaks in 1883..... IX, 41
—— Stone implements in Trego county..... VII, 60
—— The pink and white terraces in New Zealand..... XI, 26
Sayre, L. E. (See W. S. Amos for joint paper.)
—— An examination of the resinous exudation of rosinweed..... XI, 103
—— A new frame for the pocket microscope..... XII, 18
—— A study of the albuminoids..... XII, 16
—— Diluted acetic acid as a solvent for extractive substances..... XIV, 44
—— Estimation of volatile oil in mustard..... XII, 59
—— Further experiments on taraxacum root..... XIV, 42
—— Is the alkaloidal strength of tea an index of its commercial value?..... XI, 50
—— Loco-weed..... X, 65
—— Some experimental tests of the Pasteur filter..... XII, 122
—— The manufacture of binding-twine..... XII, 19
—— The quality of commercial peppers..... XI, 51
—— The solubility of chrome yellow in the gastric juice..... XI, 23
—— The extractive yield of various important vegetable medicinal substances, XIII, 120
—— Therapeutical notes and descriptions of parts of medicinal plants growing in Kansas..... XVI, 85
—— Therapeutic value of some recently introduced chemicals..... XIII, 28
—— Variable chemical composition of plants at different seasons..... XIII, 106
Scribner, F. L. A contribution to the flora of Kansas (gramineal)..... IX, 115
Sellards, E. H. Fossil plants in the Permian of Kansas..... XVII, 208
Slosson, Mrs. A. L. A partial list of fossils found in Cherokee county, Texas..... XII, 62
—— Personal observations upon the flora of Kansas..... XI, 19
Slosson, E. E. (See E. H. S. Bailey for joint paper.)
—— (See V. L. Kellogg for joint paper.)
—— The relative sweetness of different alcohols..... XII, 104
Smith, Alva J. Fusulina cylindrica, shell structure..... XVI, 64
—— The Americus limestone..... XVII, 189
Smith, H. S. S. Magnetic declination in Kansas for October, 1880..... VII, 48
—— Observations of comet "B," 1882..... VIII, 28
—— Standard time..... VIII, 30
Smyth, B. B. (See E. H. S. Bailey for joint paper.)
—— Additions to flora of Kansas..... XII, 105; XIII, 96; XIV, 133; XV, 60; XVI, 158
—— Botanical notes from the Southwest, and floral clock..... VII, 50
—— Figurate series..... XIV, 29
—— Floral horologue for Kansas..... XVI, 106
—— Harmonies of the chemical elements..... XIV, 100
—— Harmonic forms..... XIV, 46
—— Periodicity in plants..... XII, 75
—— Terminal boulder belt in Shawnee county..... XIV, 220
—— The age of Kansas..... IX, 129
—— The buried moraine of the Shunganunga..... XV, 95
—— The closing of Michigan glacial lakes..... XV, 23
—— The Topeka coal hole..... XIV, 207
Snow, F. H. Amblychila cylindriformis..... VI, 29
—— A comparison of the records of the two anemometers at the University of Kansas..... XI, 107
—— Catalogue of the birds of Kansas..... I, 375 (21)
—— Birds of Kansas, 1874..... III, 30 (123)
—— Additions to catalogue of Kansas birds..... VI, 38
—— Climate of Kansas..... I, 397 (40)
—— Catalogue of Lepidoptera of eastern Kansas, 1875..... IV, 29
—— List of Coleoptera collected in Santa Fe canon, New Mexico..... VII, 70
—— Curve of mean daily temperature at Lawrence for twenty-one years, 1868-1888..... XII, 52
—— Douglas county additions to list of Kansas Coleoptera in 1879-1880..... VII, 78
—— Experiments for artificial dissemination of a contagious disease among chinch-bugs..... XII, 34, 119
—— Insects of Wallace county, Kansas..... VI, 61
—— Is the rainfall of Kansas increasing?..... IX, 101
—— Larva and chrysalis of the sage sphinx..... IV, 28

Snow, F. H. List of Coleoptera collected in Colorado, 1876 ..... V, 15
—— List of Coleoptera collected in Colorado, 1878 ..... VI, 75
—— List of Lepidoptera collected in Colorado, 1879 ..... VII, 61
—— List of Lepidoptera collected in Colorado ..... VI, 70
—— Additions to list of Kansas Lepidoptera ..... VII, 102
—— List of Lepidoptera and Coleoptera collected in New Mexico, 1881, 1882 ... VIII, 35
—— List of Lepidoptera and Coleoptera collected in New Mexico, 1883, 1884 ..... IX, 65
—— Additions to list Kansas Coleptera, 1881, 1882 ..... VIII, 58
—— Meteorological summary, 1872 to 1889 ..... I, 196 (61); II, 19 (86); III, 28 (130); IV, 60; V, 59; VI, 89; VII, 89; VIII, 23; VIII, 81; IX, 43; IX, 124; X, 31; X, 142; XI, 115; XII, 49
—— Notes on some Kansas meteorites ..... XII, 105
—— Observations on the use of antennæ of Polyphilla variolosa ..... III, 27 (128)
—— On the dermal covering of a mosasauroid reptile ..... VI, 54
—— On the discovery and significance of stipules in certain dicotyledonous leaves in the Dakota rocks ..... XI, 33
—— On the discovery of a fossil bird track in the Dakota sandstone ..... X, 3
—— Preparatory stages of Hyerchiria zephyria ..... IX, 61
—— Preliminary list of Hymenoptera of Kansas ..... VII, 97
—— The Rocky Mountain locust ..... IV, 26
—— The Logan county nickel mines ..... XI, 39
—— The mode of respiration of the common salamander ..... XII, 31
—— Three new Kansas birds ..... XI, 62
Stevens, W. C. The union of Cuscuta glomerata with its host ..... XII, 163
Swingle, W. T. (See W. A. Kellerman for joint paper.)
—— A list of Kansas species of Peronosporaceæ ..... XI, 63
—— First addition to list of Kansas Peronosporaceæ ..... XII, 129

Thompson, A. H. (See Robert Hay for joint article.)
—— Animal ethics ..... XI, 52
—— Facial expression and its psychology ..... XII, 67
—— Memorial of Robert Hay ..... XV, 131
—— Notes on the antiquity of man ..... VI, 12
—— The descent of facial expression ..... XIII, 122
—— The influence of food selection upon the evolution of animal life ..... V, 65
—— The origin and evolution of the human face ..... XIII, 6
—— The origin and history of the Academy ..... IX, 4
—— The relation of a state geological survey to the work of the national survey ..... X, 9
Towner, H. C. Evidence of ancient forests in central Kansas ..... V, 70
Townsend, C. H. T. On the horse-flies of New Mexico and Arizona ..... XIII, 133
—— On a peculiar acalyptrate muscid found near Turkey Tanks, Ariz ..... XIII, 135
Tweeddale, W. Silica cement mortars ..... XVII, 42
—— Water purification ..... XVI, 48

Waters, Lora L. Erysipheæ of Riley county ..... XIV, 200
West, E. P. The last submersion and emergence of southeastern Kansas from the Carboniferous seas ..... IX, 106
Wheeler, Wm. A fossil tusk found in Franklin county ..... VI, 11
—— A partial list of the fishes of the Marais des Cygnes, at Ottawa ..... VI, 33
White, Mark. Geology of the Glass mountains of western Oklahoma ..... XVII, 199
Willard, J. T. (See G. H. Failyer for joint paper.)
—— A breathing well in Logan county ..... XIII, 73
—— and G. H. Failyer. A new glass siphoning extractive apparatus ..... XII, 165
—— Effect upon the composition of the soil of continuous cropping by wheat ... XVII, 41
—— Notes on the analysis of agricultural products ..... XII, 21
—— Note on a new Kansas mineral ..... IX, 25
—— and G. H. Failyer. On a new apparatus for the continuous extraction of solids by a volatile solvent ..... X, 20
—— and A. T. Kinsley. On the effects of oxygen upon animal life ..... XVII, 38
—— On the sugars of watermelons ..... XII, 95
—— On the sweetness of invert sugar, with some notes on its preparation ..... X, 24
—— On the variations in the sugar content of Sorghum vulgare ..... X, 70
—— Variations in the nitrogen content of maize, and possibilities for its improvement ..... XVI, 46

Williams, Lizzie J. What is good for an artist, and what is an artist good for? ..... I, 411 (54)
Williston, S. W. American Jurassic dinosaurs ..... VI, 42
—— An interesting food habit of the plesiosaurs ..... XIII, 121
—— A new plesiosaur from the Kansas Niobrara ..... XII, 174
—— A new turtle from the Kansas Cretaceous ..... XVII, 195
—— Memorial of E. P. West ..... XIII, 68
—— Niobrara Cretaceous of western Kansas ..... XIII, 107
—— Notes and descriptions of North American Tabanidæ ..... X, 129
—— Notes and descriptions of Mydaidæ ..... XV, 53
—— Notes on the habits of some of the rarer Cicindelidæ ..... VI, 32
—— Notice of some vertebrate remains from Kansas Permian ..... XV, 120
—— On the adult male plumage of Wilson's phalarope ..... VI, 30
—— On the structure of the Kansas chalk ..... XII, 100
—— science in education ..... XVI, 16
—— Spermophilus richardsonii ..... VI, 39
—— tables of the families of Diptera ..... X, 122
—— the Pleistocene of Kansas ..... XV, 90
Wilson, J. W. Geology of the Effingham ridge ..... XV, 113

CONTENTS OF VOLUME XVIII.

	PAGE
Present and Past Officers of the Academy	2
Membership of the Academy January 6, 1903	3
Additions to Membership List	287
Historical Sketch of the Academy	6
Constitution of the Academy	7
By-laws of the Academy	8
Minutes of the Thirty-fourth Annual Meeting, at Iola, 1901	9
Minutes of Thirty-fifth Annual Meeting, at Topeka, 1902	14
Announcements by the Secretary	286
Advertisement of previous Volumes	285

ADDRESSES DELIVERED AND PAPERS READ AT THE IOLA AND TOPEKA MEETINGS.

I.—Presidential Addresses:

Science and the Nineteenth Century. Ephraim Miller	27
The Mission and Limitations of Science. J. T. Willard	36

II.—Chemical and Physical Papers:

A Study of Dietaries at Lawrence, Kan. E. H. S. Bailey	49
Crystalline Liquids. Fred B. Porter	54
Some Kansas Petroleum. Edward Bartow and Elmer V. McCollum	57
The Composition and Digestibility of Prairie Hay and of Buffalo-grass Hay. J. T. Willard and R. W. Clothier	59
Distinguishing Red and White Oak Lumber by Chemical Analysis of their Ash. E. B. Knerr	61
On the Alkyl Sulphates. F. W. Bushong	62
Some Sandstone Waters of Great Purity. E. H. S. Bailey	68

III.—Geological Papers:

The Spanish Peaks. J. J. Jewett	73
Economic Geology of Iola and Vicinity. G. P. Grimsley	78
Notes on the Geology of the Antelope Hills. R. S. Sherwin	83
Notes on the Theories of Origin of Gypsum Deposits. R. S. Sherwin	85
Experiences with Early Man in America. Charles H. Sternberg	89
The Permian Life of Texas. Charles H. Sternberg	94
Geology of Lyon County, Kansas. Alva J. Smith	99
Further Studies in the Mentor Beds. Alfred W. Jones	104
The Ottawa Gas-wells. J. A. Yates	106
Physiographic Divisions of Kansas. Geo. I. Adams	109
List of Fossil Plants Collected in Vicinity of Onaga, Kan. F. F. Crevecœur	124
Gold in Kansas Shales. J. T. Lovewell	129
Gold in Kansas. J. T. Lovewell	134

IV.—Biological Papers:

Loco Weed. L. E. Sayre	141
Notes on the Trees, Shrubs and Vines in the Southern Part of the Cherokee Nation. C. N. Gould	145
A Provisional List of the Uredineæ of Bourbon County, Kansas. A. O. Garrett	147
Statistics about Kansas Birds. D. E. Lantz	151
Notes on the Birds of Kansas, and a Revised Catalogue. F. H. Snow	154
A New Species of Fish. F. F. Crevecœur	177
Notes on the Food Habits of California Sea-lions. L. L. Dyche	179
Food Habits of the Common Garden Mole. L. L. Dyche	183
Additions to the List of Kansas Coleoptera for 1901 and 1902. Warren Knaus	187
Preliminary List of Medicinal and Economic Plants in Kansas. B. B. Smyth	191

V.—Miscellaneous Papers:
The Drying-up of Pools and Streams in Central Kansas. S. G. Mead..... 213
Origin of Names of Kansas Streams. J. R. Mead..... 215
Loss of Teeth as a Disqualification for Military Service. Edward Bumgardner..... 217
On Certain Methods of the Geometry of Position. Arnold Emch..... 220
The Eleven-and-one-half-inch Equatorial Telescope of Washburn College Observatory. H. L. Woods..... 231
Review of the Crop Season of 1902. T. B. Jennings..... 234

VI.—Necrology:
Col. N. S. Goss..... 243
Dr. Geo. T. Fairchild..... 244
Davis A. Boyles..... 245

VII.—Appendix.
Accessions to the Academy Library, 1901 and 1902..... 249
General Index to the Academy Transactions, 1872 to 1900..... 260
Index to Volume XVIII (1903)..... 281
Advertisement of Volumes Issued by the Academy..... 285
Announcements by the Secretary..... 286
Additions to the List of Members of the Academy..... 287

LIST OF PLATES.

Lincoln College (now Washburn), Topeka, 1865..... *Frontispiece.*
Kansas Academy of Science Museum of Mineral Industries..... 8
Office and Library of the Kansas Academy of Science..... 16
Shale Pit of the Iola Brick Company, at Iola, Kan..... 80
Field south of Iola, in 1898, where the Iola Cement Mill was erected in 1899 and 1900..... 88
Iola Portland Cement Mill, 1900..... 96
Roaring Spring Cliff, Ellsworth county, Kan..... 112
Mushroom Rock, Alum Creek, Ellsworth county, Kansas..... 120
Shale Bank on the Smoky Hill River..... 128
Shale Bank near the Smoky Hill River..... 136
Smoky Hill River Valley, showing Shale Banks..... 144
Washburn College Observatory..... 216
The New Equatorial Telescope in Washburn College Observatory..... 232
Col. N. S. Goss..... 240
Dr. Geo. T. Fairchild..... 240

INDEX TO VOLUME XVIII.

PAGE

Accessions to the Academy library, 1901 and 1902 249
Adams, George I. Physiographic divisions of Kansas 109
Mentioned 3, 12, 128
Advertisement of volumes issued by the Academy 285
Alkyl sulphates. F. W. Bushong 62
Announcements 296
Antelope Hills, notes on geology of. R. S. Sherwin 82

Bailey, E. H. S. Some sandstone waters of great purity 68
Study of dietaries at Lawrence, Kan 49
Elected life member 12
Mentioned 3, 10, 14, 15, 16, 17
Baker, Harvey W. Elected to membership 16
Barker, F. D. Elected to membership 9
Bartholomew, Elam. Quoted 147
Bartow, Edward, and E. V. McCollum. Some Kansas petroleum 57
Elected vice-president 13, 18
Mentioned 2, 3, 9, 10, 14, 16, 17, 19
Birds, Kansas, statistics about. D. E. Lantz 151
Notes on, and a revised catalogue of. F. H. Snow 154
Boyles, Davis A. Memorial of 245
Brick manufacture 79, 80
Bumgardner, Edward. Loss of teeth as a disqualification for military service 217
Bushong, F. W. On the alkyl sulphates 62
Mentioned 14, 15, 16
By-laws of the Academy 8

Cherokee nation, notes on trees, shrubs and vines in. C. N. Gould 145
Clothier, R. W. Paper by 80
Cole, Clarence L. (Dr.) Elected to membership 16
Coleoptera, Kansas, additions to the list for the years 1901, 1902. W. Knaus 187
Collineation 226
Committees appointed 9, 10, 13, 15, 16, 17
Constitution of the Academy 7
Amendment to 10
Cooper, J. C. Elected president 18
Mentioned 2, 4, 19
Cragin, F. W. Mentioned 3, 120
Crevecoeur, F. F. List of fossil plants collected in the vicinity of Onaga, Kan 124
New species of fish 177
Mentioned 4, 9, 10, 20, 187, 188, 189
Crop season of 1902. T. B. Jennings 234
Crystalline liquids. F. B. Porter 54

Dains, F. B. Elected to membership 16
Paper by 18
Dietaries, a study of, at Lawrence, Kan. E. H. S. Bailey 49
Dunlevy, R. B. Papers by 20
Dyche, L. L. Food habits of the common garden mole 183
Notes on the food habits of California sea-lions 179
Elected to life membership 11
Mentioned 3, 9, 10, 14, 15, 16, 19, 20

Election of officers of the Academy 12, 18
Emch, Arnold. On certain methods of the geometry of 220

Failyer, Geo. H. Mentioned 4, 9, 10, 12, 13
Fairchild, Geo. T. (Dr.) Memorial of 244
Fish, a new species of. F. F. Crevecœur 177
Franklin, E. C. Elected treasurer 13
Mentioned 3, 10, 20

Garrett, A. O. A provisional list of the Uredineæ of Bourbon county, Kansas 147
Elected to membership 9
Gas, natural 78, 79
Gas-wells at Ottawa, Kan. J. A. Yates 105
Geometry of position, on certain methods of. Arnold Emch 220
Gold in Kansas. J. T. Lovewell 124
Gold in Kansas shales. J. T. Lovewell 129
Gold shales, committee appointed to report on 13, 16
Goss collection 14, 16
Goss, N. S. Memorial of 243
Quoted 12, 156, 157, 158, 160, 164
Gould, C. N. Notes on trees, shrubs and vines in the Cherokee nation 145
Mentioned 19, 21
Grimsley, G. P. Economic geology of Iola and vicinity 78
Elected secretary 13, 18
Report as secretary 14, 15
Report of committees on secretary's report 18
Mentioned 2, 4, 11, 12, 19, 21
Gypsum, notes on the theories of origin of gypsum deposits. R. S. Sherwin 85

Harnly, H. J. Mentioned 4, 11
Harshbarger, W. A. Elected to membership 19
Hartman, Leon W. Elected to membership 9
Haworth Erasmus. Quoted 115, 116, 117
Hay, prairie and buffalo-grass, its composition and digestibility. J. T. Willard and R. W. Clothier 59
Hay, Robert. Quoted 114, 121
Henderson, Willis E. Elected to membership 9
Historical sketch of the Academy 6
Hoxie, G. W. (Dr.) Elected to membership 16
Hoyt, W. F. Elected to membership 16
Hunter, S. J. Papers by 20

Index, general, to Academy Transactions from 1872 to 1900 260
Index to therapeutic properties of Kansas plants 208
Iola. Economic geology of Iola and vicinity. G. P. Grimsley 78
Isely, F. B. Elected to membership 18

Jennings, T. B. Review of crop season of 1902 234
Jewett, J. J. The Spanish Peaks 73
Elected to membership 16
Jones, Alfred W. Further studies in the Mentor beds 104
Mentioned 15, 20

Knaus, Warren. Additions to the list of Kansas Coleoptera for the years 1901 and 1902 187
Elected to life membership 18
Mentioned 3, 9, 10, 15, 16, 19, 20
Knerr, E. B. Distinguishing red and white oak lumber by chemical analysis of their ash ... 61

Lantz, D. E. Statistics about Kansas birds 151
Mentioned 4, 9, 10, 13, 14, 15, 17, 19, 157, 158, 159, 160, 162, 163, 187
Larkin, Pierce. Elected to membership 18
Paper by 21
Legislation 15, 18
Library 16
List of members 3, 257

Loco weed. L. E. Sayre..... 141
Lovewell, J. T. Gold in Kansas shales..... 129
Gold in Kansas..... 134
Mentioned..... 3, 9, 10, 13, 14, 15, 18
Lyon county, Kansas, geology of. Alva J. Smith..... 99

Man, experiences with early man in America. Charles H. Sternberg..... 89
Marbut, C. F. Quoted..... 112
Martin, H. T. Elected to membership..... 19
Marvin, F. O. Elected to life membership..... 18
Mentioned..... 15
Matthews, R. (Dr.) Mentioned..... 4, 12, 151, 166
McCollum, E. V., and Edward Bartow. Some Kansas petroleum..... 57
Elected to membership..... 16
McIntyre, Edith A. (Miss). Elected to membership..... 18
McWharf, J. M. (Dr.) Elected to membership..... 16
Mead, J. R. Origin of names of some Kansas streams..... 215
Mentioned..... 3, 9, 10, 11, 14, 15, 19
Mead, S. G. The drying-up of pools and streams in central Kansas..... 213
Mentioned..... 4, 11, 187
Meeker, Grace (Miss). Mentioned..... 4, 9
Mentor beds, further studies in. Alfred W. Jones..... 104
Miller, E. Science and the nineteenth century (presidential address)..... 26
Mentioned..... 3, 9, 12
Mole, garden, its food habits. L. L. Dyche..... 133
Monahan, Elmer P. Elected to membership..... 9
Morscher, L. N. Mentioned..... 4, 9
Moses, H. M. (Dr.) Elected to membership..... 16
Mudge, B. F. Quoted..... 6, 105, 114

Necrology committee report..... 12
New members elected..... 9, 12, 16, 18, 19

Oak lumber, red and white, a new method of distinguishing by the chemical analysis of their ash. E. B. Knerr..... 61
Officers of the Academy..... 2
Olin, W. H. Elected to membership..... 16
Ottawa gas-wells. J. A. Yates..... 106

Parker, Johns D. Mentioned..... 6
Past officers of the Academy..... 2
Permian life of Texas. C. H. Sternberg..... 94
Petroleum, Kansas. Edward Bartow and E. V. McCollum..... 57
Physiographic divisions of Kansas. George I. Adams..... 109
Plants, fossil, collected in the vicinity of Onaga, Kan. F. F. Crevecoeur..... 124
Plants, Kansas, preliminary list of medicinal and economic plants. B. B. Smyth..... 191
Plass, Norman (Pres.) Elected to membership..... 16
Poole, S. F. Elected to membership..... 16
Pools and streams in central Kansas, the drying-up of. S. G. Mead..... 213
Popenoe, E. A. Mentioned..... 3, 11, 15, 17, 155, 188
Porter, F. B. Crystalline liquids..... 54
Portland cement..... 81, 82
Pribble, C. L. Elected to membership..... 16
Prosser, C. S. Mentioned..... 5, 102

Quintard collection, report on..... 17

Resolutions of the Academy..... 12, 13, 21
Rice, W. H. Elected to membership..... 16
Riddle, Lumina C. (Miss) Elected to membership..... 16
Ringer, Arthur. Elected to membership..... 16

Sayre, L. E. Loco weed 141
Elected to life membership 18
Mentioned 3, 9, 11, 12, 14, 15, 16, 20, 191
Schaffner, J. H. Elected to membership 16
Paper by 17
Science and the nineteenth century. E. Miller 26
Science, the mission and limitations of. J. T. Willard 36
Sea-lions, California, notes on food habits of. L. L. Dyche 179
Secretary's report 14, 15
Report of committees on secretary's report 15, 18
Shearer, J. L. Elected to membership 16
Sherwin, R. S. Notes on the geology of the Antelope Hills 83
Notes on the theories of the origin of gypsum deposits 85
Elected to membership 10
Mentioned 11, 20
Smith, Alva J. Geology of Lyon county, Kansas 99
Elected treasurer 18
Mentioned 2, 5, 9, 10, 14, 15, 128
Smyth, B. B. Preliminary list of medicinal and economic plants in Kansas, with their reputed therapeutic properties 191
Mentioned 3, 9, 10, 11, 12, 14, 15, 17
Smyth, Eugene. Mentioned 5, 14, 15, 187, 189
Elected to membership 12
Snow, F. H. Notes on the birds of Kansas, and a revised catalogue 154
Mentioned 20, 21, 187, 188, 190
Spanish Peaks. J. J. Jewett 73
Sternberg, C. H. Experiences with early man in America 82
The Permian life of Texas 94
Mentioned 5, 9, 12, 17
Stevenson, Teresa (Miss). Elected to membership 9
Streams, Kansas, origin of the names of. J. R. Mead 215
Sulphuric acid 81

Teeth, loss of, as a disqualification for military service. Edward Bumgardner 217
Telescope, the eleven-and-one-half-inch equatorial, of Washburn College observatory. H. L. Woods 231
Treasurer's report 13, 17
Trees, shrubs and vines in the Cherokee nation. C. N. Gould 145

Uredineæ of Bourbon county, Kansas, a provisional list. A. O. Garrett 147

Ward, M. L. Elected to life membership 12
Mentioned 3, 9, 10, 12
Water, some sandstone waters of great purity. E. H. S. Bailey 68
White, David. Mentioned 128
Willard, J. T., and R. W. Clothier. The composition and digestibility of prairie hay and of buffalo-grass hay 59
The mission and limitations of science (presidential address) 36
Elected president 13
Elected to life membership 11
Mentioned 3, 9, 10, 13, 19, 20
Williams, Edward M. Elected to membership 12
Williston, S. W. Elected honorary member 18
Mentioned 3, 11
Woods, H. I. The eleven-and-one-half-inch equatorial telescope of Washburn College observatory 231
Elected to membership 15

Yates, J. A. The Ottawa gas-wells 106
Elected vice-president 13, 18
Mentioned 2, 5, 11, 14, 15, 16

Zinc smelting 80

TRANSACTIONS OF THE KANSAS ACADEMY OF SCIENCE.

Original volumes I, II, III, were published as parts of the State Agricultural Reports for 1872, 1873, 1874. (Out of print now.)

	PRICE.
Reprint of volumes I to III (1896), 135 pages, 4 figures	$0 50
Volume IV, 1875, 63 pages. (Out of print.)	
Volume V, 1876, 75 pages, 1 figure. (Out of print.)	
Volume VI, 1878, 94 pages, 6 figures, 1 plate. (Out of print.)	
Volume VII, 1881, 136 pages, 1 plate. (Out of print.)	
Volume VIII, 1883, 85 pages, 5 plates	0 60
Volume IX, 1885, 145 pages, 9 plates ..... paper, 75 cts.; cloth,	1 25
Volume X, 1887, 155 pages, 19 figures, 6 plates	1 00
Volume XI, 1889, 128 pages, 4 figures, 1 plate	75
Volume XII, 1890, 189 pages, 9 figures, 7 plates ..... paper, 75 cts.; cloth,	1 25
Volume XIII, 1893, 175 pages, 15 figures, 5 plates .... paper, 60 cts.; cloth,	1 00
Volume XIV, 1896, 370 pages, 96 figures, 8 plates ..... paper,	1 25
Volume XV, 1898, 226 pages, 2 figures, 7 plates	1 50
Volume XVI, 1899, 320 pages, 12 figures, 9 plates ..... paper, $1; cloth,	1 50
Volume XVII, 1901, 248 pages, 15 figures, 13 plates ..... paper, $1; cloth,	1 50
Volume XVIII, 1903, — pages, 35 figures, 15 plates ..... paper, $1; cloth,	1 50

Requests for the purchase or exchange of these publications, and all correspondence, should be addressed to the

SECRETARY KANSAS ACADEMY OF SCIENCE,
Topeka, Kan., U. S. A.

ANNOUNCEMENTS.

One of the duties of the Secretary is the compilation of a directory of persons interested in science work, the teachers of science in our public schools and others, in the state. Members of the Academy can greatly assist in this work by sending in to the office as many of these names as possible.

In accordance with the resolution passed at the last session of the Academy, members will please send in their photographs to the office.

Papers presented at the Academy meetings, particularly those intended for publication in the Transactions, should be typewritten carefully before being filed for publication. The printer declines to send proof-sheets all over the country because of the delay and extra expense; therefore, the proof-reading devolves on the Secretary, and correct typewritten copy is far more important to the author than to either the Secretary or the printer. It will facilitate the work of publication and avoid irritating errors that are sure to occur when manuscript copy is used. Typewrite your papers and then read them over carefully. One or two errors discovered in a printed scientific article or book frequently cast a doubt in the mind of the reader over the entire article or work.

The next meeting of the Academy will be held near the close of the year 1903, at Manhattan.

G. P. Grimsley

TOPEKA, KAN., May, 1903. *Secretary.*

ADDITIONS TO MEMBERSHIP LIST.

LIFE MEMBER.

D. E. Lantz, M. S., 1883, Kansas Agricultural College... Manhattan.

ACTIVE MEMBERS.

W. F. Hoyt, A. M., 1902, president of Kansas Wesleyan University ..... Salina.

J. M. McWharf, M. D., 1902..... Ottawa.

Lumina C. Riddle, M. S., 1902, Ohio State University... Columbus, Ohio.

J. D. Walters, M. S., 1894, Kansas Agricultural College, Manhattan.

AUXILIARY COLLECT
DOES NOT CIRCULA

Stanford University Library
Stanford, California

In order that others may use this book, please return it as soon as possible, but not later than the date due.